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An evaluation of the AWS Entry Level Welder Training Program

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AN EVALUATION OF THE AWS

ENTRY LEVEL WELDER TRAINING PROGRAM

A Dissertation

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Doctor of Industrial Technology

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ABSTRACT

The purpose of this study was to evaluate the effectiveness of a training program for Entry Level Welders and to provide this information to the American Welding Society (AWS), industry, and educators. The problem of this study was to evaluate the AWS Entry Level Welder Training Program (ELWTP) by obtaining the opinions of faculty members who taught the program and welders who had completed the program.

Two groups comprised the research population for this study. The first group consisted of faculty members who were actually involved in teaching the course at institutions accredited by the AWS to offer the curriculum. The second group consisted of all graduates of the program registered as Certified Entry Level Welders. There were 118 Certified Entry Level Welders and 251 registered institutions (faculty) on lists furnished by the AWS.

A questionnaire was developed based on the curriculum guidelines presented in AWS Manual EG2.0-95, <u>Guide for Training and Qualification of Welding Personnel-Entry Level Welders</u>. These guidelines direct the institutions in providing competency-based training that leads to the certification of trainees in accordance with AWS specifications. The ELWTP consists of six Courses which are further divided into 65 Learning Objectives. These Courses

and Learning Objectives provided the framework for the questionnaire. Respondents (faculty and graduates) were asked to evaluate the course content of each of the 65 Learning Objectives by means of a five-point Likert Scale, and the means for welders and faculty were compared.

The results of the study indicated that, of the six ELWTP Courses, only Course B. Drawing and Welding Symbol Interpretation had a preference by both welders and faculty to have the course content "Increased Slightly." In general, both welders and faculty members were satisfied with the Courses and Learning Objectives as offered by the ELWTP with welders slightly favoring increases in instructional content.

DEDICATED TO

MY WIFE

MARGIE ANN RICE

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INTRODUCTION

Overview

The American Welding Society (AWS) has developed an Entry Level Welder Training Program (ELWTP) in an effort to standardize this area of the welding industry. This program consisted of published standards and a curriculum for participating schools and industries to use in implementing training programs. The AWS established the ELWTP after an extensive needs assessment was conducted. Information was obtained by contacting experienced industrial and educational representatives. The information received from this survey was used to determine the requirements for employment as an entry level welder.

This study, as presented here, was conducted in an attempt to evaluate the effectiveness of the AWS Entry Level Welder Training Program. A questionnaire was sent to samples of educators (faculty) who presented the program, and to students (graduates) who had successfully completed the training. Evaluation of any method or area of training, with proper feedback, should lead to upgrading and improvement of the training. The goal of this research was to make a contribution to future improvements in the training program and, consequently, to the welding industry.

A brief history of the Entry Level Welder Training Program was best described in a letter written by Dr. Frank G. De Laurier, Executive Director of the American Welding Society (March 24, 1995):

> On July 2, 1993 the American Welding society was awarded a grant through the U.S. Department of Education to develop, organize and operate a business-labor-education committee, the AWS Education Grant Committee, that participated in the preparation of a skills standard and curriculum leading to the certification of individuals as "entry level welders." The project title was "Business and Education Standards Program-Development of Standards and Certification for Entry Level Welders." The total cost of the project was $1,072,466.85. The portion funded with Federal funds was $529,813.00 (49%). The portion funded by the American Welding Society was $542,653.85 (51%). The three deliverables of the project include:
>
> A standard for Entry Level Welders (AWS QC10)
> A curriculum for training Entry Level Welders (AWS EG2.0)
> A certification program for Entry Level Welders.

In 1995 an extension to the original grant was provided. This resulted in the Level II and Level III training programs and added six similar deliverables. Only the Entry Level Welder Training Program (Level I) was evaluated in this study.

According to the U.S. Bureau of Census for 1990, approximately 644,000 men and women identified themselves as welders or cutters (Cullison, Woodward, & Johnsen, 1993). Giachino and Weeks (1976) cited figures from the U.S. Department of Labor indicating 550,000 persons were employed as welders. There were no figures available to identify those certified by any type of qualification standards. The AWS program presented in this study created a national standard and registry which, hopefully, would eventually address this problem by maintaining a databank of all certified welders and their qualifications.

As of September 1997, 118 students had successfully completed the program certification requirements and were listed in the AWS National Registry. Additionally, 251 educational institutions had been registered as AWS Participating Organizations through the "Schools Excelling through National Standards Education" (S.E.N.S.E.) program. The 251 educational institutions were located in 37 states. The program continues to be introduced in schools across the country where it is intended to become a permanent part of the curriculum.

The study presented here, to evaluate the effectiveness of the AWS Entry Level Welder Training Program (ELWTP), has included the graduates of the ELWTP (certified entry level welders), as well as the educational institutions, who were involved in the program. A questionnaire survey sent to welders and faculty members was used to obtain their opinions of various phases of the training program. The results of the survey produced program evaluations from both faculty and welders. In the study conducted here, all data were collected after the students had completed the required curriculum and had entered the workplace. None of the students knew of this forthcoming evaluation when they completed their training. Their opinions were solicited by asking for personal evaluations of the training program courses after graduating. The literature search revealed no studies in which students trained in welding had been contacted only after completion of their training to provide information about the curriculum. The literature review produced only a few doctoral dissertations or similar studies which were specifically related to the topic of this study. The following paragraphs summarize the studies which are most closely related.

One of the earliest studies involving training requirements for welders was a doctoral dissertation by Morgan(1968). Morgan referred to a doctoral study by Donald E. Maurer (1966) which indicated that the "welding industry is experiencing a period of intense development" (p. 17). Morgan's literature research found this to be the only doctoral dissertation which dealt with welding technology. The purpose of Morgan's study was, in part, to ascertain the nature of the occupational preparation desired for welding tradesmen. He concluded that "a great need exists for welding technicians and technologists to receive pre-employment preparation in those areas represented by the items classified as related information" (p. 4). Morgan recommended further research to ascertain the level of skill desired in pre-employment preparation of welding tradesmen.

Evaluation techniques, as well as studies involving welding, were also investigated. Jones (1978) developed a model for evaluation of employee training programs for a doctoral dissertation at Cornell University by extensively reviewing existing models and building on them. He pointed out that the most difficult aspect of evaluation to measure is behavior or performance. His findings also revealed that limiting factors in evaluation are lack of appropriate standards, expertise, and resources. Since behavior is the most important area of measurement and also the most difficult to measure, it may be distorted when employees modify their behavior because of the presence of an observer. Conclusions by Jones indicated that the use of scales and other rating forms may be the superior approach to quantifying behavior. His feelings were that current designs for evaluation were inadequate. Many people feel threatened by evaluation systems and a way of reducing this perceived threat is to involve the people who are being evaluated. This concept has been used, in part, to develop the study of Entry Level Welders presented here.

Another doctoral dissertation by White (1991) at Texas A&M University evaluated training needs of manufacturing firms. One of the most significant findings of the study was the anticipated increase required for new employees in each of the next three years. Manufacturing employees and welders were included in the predicted high demand occupations. The results indicated current and future shortcomings of specific occupational skills. The results also revealed that employers were willing to contribute to training programs if they applied to the needs of the industry.

Some advanced research projects were listed by Irving (1993) in an article describing how the U.S. Government had offered assistance to the welding industry. These topics further illustrated the need for continued training of welders. Federal agencies were offering help in many of these areas in response to the Federal Administration's urging to transform "swords into plowshares" (p. 77). A partial listing of these research projects follows: (a) Welding of single crystal turbine alloys, (b) Laser welding with powder metal additions, (c) Welding of Ti Alloy C, and (d) Welding of Aer Met 100. Companies which were involved in these research activities included Westinghouse, Pratt and Whitney, Boeing, and General Electric. When successful research leads to advanced welding technology, presumably the demand for qualified welders will increase. This demand can be met only through education and training of those who will be called upon to do the work.

Murray (1997), in an article titled How Can We Help Today's Students, stated "our educational system is in complete chaos" and "the educational system is crippling rather that educating our children" (p. 17). As a retired professor of Welding Technology, he felt the multiplicity of processes and systems created a confused social and educational climate. He indicated that education involves the transfer of knowledge which begins with the teacher and that the delivery of this knowledge needed to be simplified. He also thought that education must be provided in preparation of available "global markets" and that students should be prepared educationally and socially to meet the demands of the world. He presented some interesting opinions but admitted that he did not have all the answers.

The ELWTP

The program requirements for the AWS Entry Level Welder Training Program were set forth in the publication AWS QC10-95, Specifications for Qualification and Certification for Entry Level Welders. The abstract includes:

> The certification of entry level welders requires performance qualification and practical knowledge tests. These tests require a minimum of reading, computational, and manual skills to complete. (p. i)

These tests are further described in QC10-95 as follows:

4.0 Practical Knowledge Test

4.1 The practical knowledge test is a written closed-book examination designed to show that the Entry Level Welder understands the following subjects:

Welding and Cutting Theory
Welding and Cutting Inspection and Testing
Welding and Cutting Terms and Definitions
Base and Filler Metal Identification
Base and Filler Metal Selection
Common Welding Process Variables
Electrical Fundamentals
Drawing and Welding Symbol Interpretation
Fabrication Principles and Practices
Safe Practices

4.2 A minimum passing grade of 75% is required with at least 90% of the safety questions answered correctly, with a limit of three retests. (p. 3)

5.0 Performance Tests

Performance tests are designed to show that the Entry Level Welder can:

1) Read and interpret simple drawings and sketches, including welding symbols.
2) Follow written procedures
3) Cut parts to proper size and fit simple assemblies
4) Pass a limited thickness SMAW qualification test in the horizontal (2G) and vertical (3G) positions.
5) Pass workmanship tests using GMAW and FCAW (Figures 1 and 2) in carbon steel, and
6) GTAW (Figures 3 through 5) in carbon steel, stainless steel, and aluminum sheet metal. (p. 3)

Total instructional content for the ELWTP is approximately 1200 hours, of which 800 hours is for hands-on training. A variety of performance tests are specifically described in detail which each welder must successfully complete.

Documentation is then required by the training organizations with a formal written report. This must include such information as welder identification, written test grades, results of workmanship tests, and visual examination. The report is then sent from the training organization direct to the AWS where it is entered in their database. This Entry Level Welder database then functions as the National Registry of Entry Level Welders.

The AWS serves its constituency through a network of local "sections" across the country. These sections will soon be able to act as testing centers. In areas where there are no S.E.N.S.E. (Schools Excelling through National Standards Education) Participating Organizations sections will also have the option of offering the ELWTP (AWS Sections Extend Help, 1996). The ELWTP, which was introduced by the AWS at the 1995 Cleveland Show, was soon followed by the Level II Advanced Welder program unveiled at the 1996 Chicago Show (Advanced Welder Curriculum and Certification Program Ready, 1996).

History of Welding

This condensed history has been presented here as partial justification for this study. The technology of welding probably extends to nearly every area of industry, whether directly or indirectly. This interesting history of welding has assembled some of the major developments as an attempt to associate the effect of the past and to illustrate, in part, what the future holds for various welding processes. Only through improved education and training will the technology be developed to perpetuate this extensive industry.

The historic development of welding can be traced back to ancient times. One of the earliest examples consisted of small gold boxes apparently made by pressure welding, more than 2000 years ago (Cary, 1989). Examples of weldments, tools, and weapons have been found which were made approximately 1000 B.C. The development and history of welding can be important to understanding current problems and to an assessment of what the future may hold. A reference to the history of welding was made, in part, by Kennedy (1982):

> The earliest method of joining two pieces of metal into a unit was by heating them and allowing them to melt together. This union known as fusion, has changed little from ancient times. Forging, as done in the past by blacksmiths, is a type of fusion.
>
> Today, heat for fusing the joint during welding comes from a burning gas or an electric current.
>
> Electric current is now the most commonly used heat source. (p. 1)

A paragraph from Sondey (1989) describes some of the early progress of welding:

> Welding history begins with the ancient forge, flow and pressure welding as well as brazing and soldering techniques of the Bronze and Iron Ages. The efforts of these ancient peoples often produced spectacular results. Until the late 19th century,

> blacksmiths used forge welding to join kitchen utensils, farm equipment, chains and gun barrels. More advanced welding technologies could not develop until advances occurred in the fields of electricity, chemistry, physics and metallurgy. (p. 2)

According to Winterton (1962a), "it is not easy to find good examples from these very early times of deliberate joining by hammering or pressure that would merit the name of welding by modern definition" (p. 438). One early example of forge welding was the "iron head-rest of Tutankhamen, made about 1350 B.C." (p. 439). Forge welding consisted of heating the iron to a near-melted condition, applying a flux, and hammering the material while it was still hot. Another paragraph by Winterton has attempted to describe some of the difficulty in tracing the history of welding:

> There is the somewhat brash claim that the welding of iron "Kollesis" was invented by a Greek, Glaukos of Chios, in the period 700-600 B.C., but, though this "discovery" may have heralded a more extensive usage, there is little doubt that forge welding must have been used many times and many centuries earlier. (p. 439)

An article by A. N. Kornienko in 1982 suggested that a Russian, N. N. Bernardos, was the inventor of carbon arc welding in 1881. At that time he "demonstrated in Paris the process of joining metals that became a classical process and was given the name of Bernardos's Electric Arc Welding" (p. 145). However, according to Winterton (1962b), "it is generally accepted that the first man to use the heat of the arc for joining was Auguste de Meritens" (p. 488). Apparently Bernardos was a pupil of Meritens and is usually given credit for the invention. According to Cary (1989), Bernardos obtained patents in 1885 and 1887 which led to the actual beginning of arc welding (carbon arc) involving iron and lead. The first U.S. metallic electrode patent was awarded to C. L. Coffin in 1890. The first coated electrode was apparently introduced by Strohmenger in Great Britain in 1900. The coated electrode was invented by Oscar Kjellberg of Sweden around 1907 (Cary, 1989). Important historical welding events condensed from Peter Houldcroft (1973) have been assembled in chronological order. Houldcroft also pointed out that his list was incomplete because "the assessment of such recent events is unreliable" (p. 443). The list, using Houldcroft as a source, is as follows:

1880-1885 Carbon-arc welding developed by Bernardos (Russia) and Coffin USA).

1890-1892 Metal-arc welding with bare wire developed by Slavianoff (Russia) and Coffin (USA)

1903 Oxy-acetylene welding invented and in use in Europe.

1907 Coated electrode developed by Kjellberg of Sweden.

1909 Covered electrode developed by Strohmenger of Britain. This was the famous Quasi-Arc electrode which used a wrapping of asbestos yarn.

1911 Mechanized flame-cutting introduced in USA. The beginning of mechanization in welding technology?

1918 Arc-stud welding first used by the Royal Navy.

1919 American Welding Society formed.

1923 Institution of Welding Engineers formed (later to be the Institute of Welding and, later still, The Welding Institute).
1935 Submerged-arc welding developed in the USA by Linde.
1939 Stud welding (previously used by the Royal Navy)applied for the first time in the USA and on a large scale for aircraft carriers, etc.
1939 Arc-air gouging developed in USA.
1940 Construction of 'Liberty' ships begins.
1941 Inert-gas tungsten arc welding developed in the US aircraft industry.
1942 Failures of Liberty ships draw attention to fracture problem in welded structures.
1943 Three-phase resistance welder by Sciaky in USA.
1948 Inert-gas metal-arc (MIG) process developed by Air Reduction Company in USA.
1949 Structure of Abbey Steelworks, South Wales, fabricated entirely by welding.
1953 Iron powder electrodes produced in USA.
1953 CO_2 used for shielding in automatic spray-transfer type welding in USA and similarly for semi-automatic welding in Russia.
1954 Bernard Welding Equipment Co. (USA) introduces automatic welding in CO_2 with cored wire.
1954 Lincoln Electric Co. (USA) devised cored wire for use without gas shield (No-gas welding).
1955 Arc-air gouging introduced to UK, fifteen years after its development in USA.
1960 Mixtures of argon and CO_2 introduced in Europe and USA for practical MIG welding of steel.
1968 Welding Institute proposes general standard for weld quality based on significance of weld defects.

Several other events, which were historically significant according to Hart and Irving (1944), are included:

1979 Austenitic stainless steel LNG tanks welded with type 308L stainless steel filler metal using gas tungsten arc welding. (p. 37)

1981 CO_2 laser viewed as a promising application area in automotive assembly lines. (p. 38)

1988 Robots used in welding, and capable of vision, touch sensing, and coordinated motion. (p. 39)

The February, 1997 issue of the Welding Journal described another event titled Nomination of AWS Fellows:

1990 AWS established honor of Fellow of the Society to recognize members for distinguished contributions to the field of welding. (p. 65)

The literature contained many interesting developments other than those presented in the foregoing. Only time will establish their proper place on the list of historical values related to the welding industry.

The American Welding Society

The AWS, with headquarters in Miami, Florida, serves the welding industry in many ways. According to their 1996 catalog, the mission and membership were described as follows:

> The mission of the American Welding Society, founded in 1919, is to provide quality services to its membership and the industry which will advance the science, technology and application of materials joining throughout the world. The work of over 25 Standing Committees and nearly 100 Technical Committees serves as the cornerstone of AWS. More than 1,200 dedicated members volunteer their time and expertise to these Committees. The pool of knowledge and the service represented by these professionals are considered to be two of the Society's most valued assets.
>
> The Society's 45,000 members consist of educators, engineers, researchers, welders, inspectors, technicians, welding foremen, company officers, and supervisors. Interests include automatic, semiautomatic and manual welding, as well as brazing, soldering, ceramics, lamination, robotics, thermal spraying, and lasers. Activities include initiatives

> in research, safety and health, education, training, business, and government liaison. (p. 2)

In addition to the three levels of welder certification, the AWS offers certification programs in Welding Inspection (CWI) and Welding Education (CWE). They are currently developing a program in Non-Destructive Evaluation (Hufsey, Holdren, & Cullison, 1996).

The AWS offers many other services and assorted literature including a monthly publication, Welding Journal. Two of the best known publications include the Welding Handbook and the D1.1 Structural Welding Code - Steel. Assorted technical and promotional literature indicates that a variety of seminars, in-house training programs, and catalogs are published by the AWS. According to one source, more than 175 documents are published in the form of codes, recommended practices, and guides of which 128 are approved by the American National Standards Institute (AWS, 1996b). Membership in the AWS includes the monthly magazine and assorted publications, as well as a variety of discounts, insurance plans, and other benefits.

Although the AWS D1.1 Structural Welding Code is the one most closely related to this study, it should be pointed out that a number of other organizations have developed their own codes. In general, a code involves regulations covering materials, fabrication, inspection, testing, and qualifications of welders. They usually cover specific areas of work such as structural steel, ship building, boilers, tanks, aircraft, etc. Sometimes codes are enacted into law in the interest of safety and to increase enforceability. Some nationally recognized organizations which have established welding codes are as follows:

American Welding Society (AWS)
American Society of Mechanical Engineers (ASME)
American Petroleum Institute (API)
American National Standards Institute (ANSI)
American Institute of Steel Construction (AISC)

The AWS _1996 Annual Report_ indicates total revenues of approximately $17 million, a net worth of $8 million, and a membership of 46,000 (p. 10). The total number employed in fabricated structural metal products (Standard Industrial Classification 344) in 1994 was 401,000 and in all fabricated metal products was 1.4 million (U.S. Bureau of the Census, 1996). Of those totals, the AWS membership represents approximately 12% and 3% respectively

Welder Certification

Certification in any field of expertise, at any level, implies a guarantee or assurance of certain qualifications, skills, or abilities. Information contained in the certifying documents are deemed reliable to permit others to depend on the qualifications of individuals who are certified. Welders are qualified by successfully passing certain skill tests required by codes or specifications. Historically, the welding trade has not had a universally accepted certification process for all areas of the profession. Various segments of the welding industry such as structural steel for buildings and bridges, boilers, pipelines, etc., have their own qualification requirements. Structural steel welders usually are qualified under the provisions of the Structural Welding Code-Steel (ANSI/AWS D1.1) issued by the American Welding Society (AWS). The procedure requires the welder to weld together small steel plates for testing purposes. The plates are then cut into smaller pieces (specimens) and subsequently bent in a horseshoe shape to expose, or "open up" the critical area of the weld. If the weld meets the AWS requirements for allowable cracks and slag inclusions, the welder is said to have passed the test. Certification is involved only when written documentation is issued either by the employer or an independent testing laboratory. These certification papers are not usually given to the welder. Some companies require all new welding employees to be tested. They do not accept previous certifications and do not furnish certification information to other employers. According to Kennedy (1982):

> To be a qualified welder, you must have enough training and skill to make a weld which meets job specifications A certified welder, however, is one who has made welds according to certain standards and who has a written certificate testifying to that fact. (p. 6)

Although there are no standardized certification requirements for all segments of the welding trade, certification by an employee in one or more areas can be extremely beneficial. Some benefits include the continued connection to professional organizations, assurances of education and knowledge, and self-confidence retained by a certified welder. The most obvious benefit of certification is marketability, whether an individual is seeking a new job, trying to advance to a higher position, or only looking to retain their current level of employment during a time of downsizing. Certification, then, means the attainment of a higher level of expertise. It is a mark of distinction which sets an individual apart from others. It also demonstrates an individual's initiative to growth and commitment to the trade.

In 1990, the American Welding Society (AWS) announced a comprehensive program to certify the qualifications of welders nationwide (Certified Welders National Registry Launched, 1990). This program required the completion of a series of standardized skill tests. Certified Welding Inspectors (CWI) administered the program at various facilities accredited by the American Bureau of Shipping (ABS). Welders were required to be qualified to ANSI/AWS D1.1, Structural Welding Code-Steel with the shielded metal arc welding (SMAW) process being selected because of its use in approximately "60% of all welding repair and fabrication operations" (p. 86). An eye examination was also required in addition to the welding tests although there were no written or verbal requirements.

A nationwide registry of certified welders was to be maintained by AWS, listing each welder's qualifications. A computer printout of this registry was to be available to employers for $10 plus $0.10 per name. The program was established to eliminate the need for retesting and to ultimately save the welding industry millions of dollars. The cost which each welder must pay for testing was to be established by each test facility. A registration fee of $25 was then required to be included on the National Registry of Certified Welders with an additional $15 charge per qualification. Welders were to provide semiannual verification of employment to maintain their names on the registry. The article stated that "the AWS Certified Welder program is the product of many years of study," that "certification will provide a performance benchmark for career development," and "plans are under way to expand the program to include additional welding codes and processes" (p. 86). The first welder became certified under this program in February,1990 (Swenson, 1997). Lennart Swenson, formerly a steel erection ironworker, converted to welding after becoming injured. His letter points out how the

Certified Welder program has helped him and reduced the constant retesting process. He concluded by stating:

> I personally hope that one day all welders will become nationally certified, and that all manner of tests and procedures will be offered through a large network of approved testing facilities and the AWS Certified Welder program has been an entirely positive experience for me. (p. 15)

Another source of certified welders is the National Welding Registry (NWR). According to Rohr (1993):

> The National Welding Registry is a new organization that registers qualifications and work histories of welders, welding inspectors, and nondestructive-test technicians. It makes available to employers through a nationwide network, certification reports and resumes of member welders. (p. 57)

The registry can also be used by welders to locate job opportunities. This registry appears to be unique in that a log of each welder's activities is maintained to indicate the processes and procedures in which the welder has been involved. Welders pay five dollars per month to be included in a nationwide listing of qualified personnel. Every six months, a welder receives a form to give to his current employer to validate and update the certification. The employer notes the date and procedures used by the welder and then returns the form to NWR. The integrity of the system is maintained by this system of third-party documentation. This information is entered into a computerized data-base to update the welder's records. Another feature of this registry is the creation of a resume for welders to present to prospective employers. Employers also have the benefit of custom sorted manpower lists. Companies can specify welders with an assortment of qualifications from varied areas of expertise.

As with the AWS certification program, the NWR promotes the advantage to employers of a direct cost savings by reducing or eliminating the need for recertification of welders. Welders gain an advantage by being able to document their qualifications without taking another performance test. Repeated attempts by the writer to contact the NWR by phone and mail were unsuccessful.

Certifications have long been industry held. That is, welders have been tested and certified with the actual certification documents being retained by the manufacturer or employer. This type of certification usually is not given to the welder or to future prospective employers. Competitive considerations, as well as liability factors, enter into these types of decisions. The new AWS program is intended to reduce or alleviate this problem for entry level welders. Its success will depend on the combined cooperation of all those involved; industry, education, and welding tradesmen.

Statement of the Problem

The problem of this study was to evaluate the AWS Entry Level Welder Training Program (ELWTP) by obtaining the opinions of faculty members who taught the program and welders who had completed the program. The perceptions of the faculty were compared to those of the welders for each course of the ELWTP.

The research problem may be stated as follows:

> Which courses offered in the AWS ELWTP should have the instructional content increased or decreased in the opinions of faculty members and welders who have completed the program?

Purpose

The purpose of this study was to evaluate the effectiveness of a training program for Entry Level Welders and to provide this information to the AWS, industry and educators. Identification of training needs or deficiencies determined by this study could possibly be included in the AWS program evaluation cycle. This study could also be used as a basis for continued research in the field of welder training. The study could also provide educators and welders with insight into the differences between them as indicated by their responses to the survey. Educators will be able to revise and upgrade their training techniques. Welders may develop self esteem and improved marketability. Society will benefit from higher quality welding through improved products and safer construction.

Statement of Need

Based on the review of literature, the requirements for standardized welder certification, and changing technological procedures, the need for a universal welder certification training program is evident. Similarly, if a training program is necessary, an evaluation of that program should be made. Helzer (1986) emphasized this changing technology, stating "there are about 70 thousand alloys in use today, not to mention hybrid materials composed of both metal and composite material" (p. 7). He also mentioned the advances in high-strength steel, laser welding, and robotic technology. Helzer's recommendations included the need for further studies regarding curriculum development.

The American Welding Society (AWS) has expended considerable resources including time, effort, and money over a period of several years to develop the Entry Level Welder Training Program (ELWTP). Approximately one million dollars of taxpayer money has been invested in these welder training programs. It seems only reasonable that some sort of evaluation of the program should be made now that a number of students have successfully completed the requirements. Identification of successes, as well as shortcomings, can be used to continue the program in a direction consistent with the original goals. Additional time may need to be added to some of the learning objectives and others may need to be reduced in content.

The AWS has added two more levels (Level II and Level III) to the national skills standards. Level II is identified as "Advanced Welder" and Level III as "Expert Welder." Guides have been produced, printed, and distributed for each of these. Possibly some skills could eventually be redistributed among the three levels.

Since 251 educational and industrial organizations have included these new standards, feedback from an evaluation would permit revisions before the system is developed more extensively. This would also apply to the many organizations currently adopting the standards as well as future ones.

Approximately 20 years ago, Giachino and Weeks (1976) stated "it is almost impossible to name an industry, large or small, that does not employ some type of welding" (p. 1) and "employment of welders is expected to increase because of the development of newer and better welding processes" (p. 7). Another reference to the significance of welding was presented by Kennedy (1982) "the art of producing new metals, as well as joining metals, is as important for survival in our space age society as it was to the people of ancient times" (p. 1).

As new welding processes continue to improve and become available, welders will be required to become trained in these techniques. Methods using plasma arc, laser, and electron beam are variations of the basic welding principles (Kennedy, 1982). Over the years, and throughout the historical development, welding costs have been significantly reduced to the point where welding is an attractive economical process. When these methods become economical, practical, and feasible, the welders who can apply them will be foremost in demand.

The AWS realizes that yesterday's programs may not always be adequate and, consequently, have volunteer members of the AWS Qualification and Certification Committee monitor its programs (Hufsey, 1995). Proposed changes have recently been made to the AWS premier certification program, the Certified Welding Inspector Program. Provisions for a new senior level and for continuing education requirements have been suggested. Hufsey described the key role of the success of the AWS Entry Level Welder Program and stated that the "committee is constantly evaluating ways to make this program meet the needs of the industry" (p. 10). He also stated "AWS will always be receptive to new ideas and improvements" (p. 10). Referring to the ELWTP Guide (AWS EG2.0-95), the AWS (American Welding Society, 1995a) has declared that "this standard is subject to revision at any time" and "any pertinent data that may be of use in improving this standard are welcomed" (p. ii). Another statement declares "it is the intent of this document to serve as a Guide for those wishing to establish, expand, or enhance a private or public training program for Entry Level Welders" (p. v). Further, the guide contains requirements "established as a result of individuals from a broad range of businesses, job classifications and industrial or educational areas participating in a national survey to identify entry level welder skills" and that the AWS "welcomes comments on this publication" (p. v).

Education is a lifelong continuing activity in all areas of technology, including welding. A survey of faculty and welders opinions of the Level I Program will identify possible differences of opinion in the various learning objectives. Only through continual upgrading can the level of training remain current in any type of technology education. This study will contribute to that upgrading.

In summary, the following reasons describe the need for an evaluation of the AWS ELWTP:

1. Approximately one million dollars of taxpayer money has been expended.

2. The extensive use of welding in industry.

3. A recognition and commitment to change by the AWS.

4. There is a continuing search by institutions to improve their training programs.

5. The U.S. Department of Education requires an evaluation of federally funded programs.

Research Questions

The following research questions were examined in association with this study:

1. Which courses and learning objectives of the AWS Entry Level Welder Training Program should have the content increased or decreased based on the opinions of faculty members?

2. Which courses and learning objectives of the AWS Entry Level Welder Training Program should have the content increased or decreased based on the opinions of graduates of the program?

3. What are the similarities and differences between the opinions of faculty members and graduates?

Assumptions

Several assumptions were made in conducting this study. The following were specifically related to the two populations:

1. The faculty members sampled from the list of participating organizations provided by the American Welding society (AWS) were assumed to be representative of those teaching the Level I training programs.

2. It was assumed that the respondents from the trained welders represented an adequate sample of that group.

3. It was assumed that all members of both populations would be objective and truthful in their responses.

Delimitations

This study was delimited to two populations. Both were furnished by the American Welding Society (AWS). The first population consisted of welding faculty at educational institutions qualified to offer the AWS Level I program. The second population consisted of all welders (graduates) currently listed in the AWS National Registry of Level I Certified Welders.

Further delimitations placed on this study were as follows:

1. The population of welders was delimited to those who had successfully completed the AWS Level I Program.

2. The population of educators (faculty) was limited to those from institutions registered as Participating Organizations in the AWS S.E.N.S.E. Program.

3. Only welding activities covered in the AWS Level I Program were used in the evaluation. Refer to AWS Publications QC10-95 and EG2.0-95.

Methodology

This study involved two populations as described in the Delimitations section of this report. Both were selected from lists furnished by the American Welding Society (AWS). Questionnaires were sent to the entire population of 118 welders listed in the AWS National Registry of Level I Certified Welders. Questionnaires also were sent to faculty members at the 251 educational institutions from which the welders received their instruction. The entire populations of both welders and faculty were selected in hopes of a significant response rate. There is a tendency, according to McCallon and McCray (1995) for certain educational levels not to respond to questionnaires. A dollar for coffee or a soft drink was sent with each welder's questionnaire to increase the possibility of a higher return rate.

The procedure followed in conducting this study was as follows:

1. A literature review was conducted to determine what previous studies had been made and what the pertinent results were.

2. A questionnaire (with cover letter) was mailed to each educational institution and welder along with a return self-addressed, stamped envelope. A subsequent reminder note was sent to nonrespondents after two weeks.

3. When the responses were completed, they were assembled, sorted, and analyzed.

4. The data were analyzed by calculating descriptive statistics for each of the 65 learning objectives. The statistics consisted of the mean value, standard deviation, t value, and probability, p. A two-tailed t-test was used to determine if a significant difference existed between the two population means at the .05 level of significance.

5. The results were reported, conclusions listed, and recommendations were made concerning possible future studies.

Four experts were selected to validate the questionnaire. Based on their subsequent suggestions and recommendations, the survey instrument was edited and revised. A survey cover letter described the study and use of the collected information. The four experts used in the validation process are identified in Appendix C.

Survey Instrument

A questionnaire was developed based on the curriculum guidelines presented in AWS EG2.0-95, Guide for the Training and Qualification of Welding Personnel - Entry Level Welders. The questionnaire consisted of 65 questions which followed the learning objectives suggested in the guide. The learning objectives, as provided by the AWS, combine to make up six basic courses as follows:

1. Occupational Orientation
2. Drawing and Welding Symbol Interpretation
3. Arc Welding Principles and Practices
4. Oxyfuel Gas Cutting Principles and Practices
5. Arc Cutting Principles and Practices
6. Welding Inspection and Testing Principles

Each of these courses was then further divided into learning objectives as outlined in the AWS guidelines. Respondents (faculty and graduates) were asked to evaluate each learning objective. A five-point Likert scale was provided for this comparison. A copy of the questionnaire is provided in Appendix E. Cover letters are furnished in Appendix F.

Dissertation Budget

Appendix A lists the research budget of expenses anticipated to cover costs associated with the study. The budget included such items as review of literature, printing, copying, supplies, and postage. It also included an amount for the final report, binding, and copyright costs. The total amount budgeted was $1400.00. A record of the actual costs was maintained throughout the study. This finalized actual cost totaled $1299.82. The actual costs have been included for comparison purposes and for the information of other researchers. The detailed distribution can be used as a reference for expenses to be anticipated in future dissertations.

Definition of Terms

Most of the terms defined in this section are standard in the welding industry. They were furnished here to provide insight for readers unfamiliar with the subject matter and to serve as a review for those who have had previous exposure.

The following definitions were reproduced from the American Welding Society (1976) publication Welding Terms and Definitions:

Arc welding (AW). A group of welding processes which produces coalescence of metals by heating them with an arc, with or without the use of filler metal. (p. 2)

Manual welding. A welding operation performed and controlled completely by hand. See automatic welding, machine welding, and semiautomatic welding. (p. 18)

Weld. A localized coalescence of metals or nonmetals produced either by heating the materials to suitable temperatures, with or without the application of pressure, or by the application of pressure alone, and with or without the use of filler material. (p. 31)

Welder. One who performs a manual or semiautomatic welding operation. (Sometimes erroneously used to denote a welding machine. (p. 31)

Welding technique. The details of a welding procedure which are controlled by the welder or welding operator. (p. 32)

Automatic welding. Welding with equipment which performs the welding operation without adjustment of the controls by a welding operator. The equipment may or may not perform the loading and unloading of the work. See machine welding. (p. 2)

Machine welding. Welding with equipment which performs the welding operation under the constant observation and control of a welding operator. The equipment may or may not perform the loading and unloading of the work. See automatic welding. (p. 18)

Semiautomatic arc welding. Arc welding with equipment which controls only the filler metal feed. The advance of the welding is manually controlled. (p. 25)

Welding. A materials joining process used in making welds. (See the Master Chart of Welding and Allied Processes.) (p. 31)

Welder certification. Certification in writing that a welder has produced welds meeting prescribed standards. (p. 31)

Welder performance qualification. The demonstration of a welder's ability to produce welds meeting prescribed standards. (p. 31)

Welder registration. The act of registering a welder certification or a photostatic copy thereof. (p. 31)

The following definitions were reproduced from the American Welding Society publication Specification for Qualification and Certification for Entry Level Welders (QC10-95):

Participating Organization. Any organization meeting 3. Requirements for Participating Organizations. (p. 1)

Entry Level Welder. An individual who possesses a prerequisite amount of knowledge, attitude, skills, and habits required to perform routine, predictable, repetitive, proceduralized tasks involving motor skills and limited theoretical knowledge while working under close supervision. (p. 1)

Summary

A program to provide training for welders has been developed by the American Welding Society (AWS) and installed at various public schools, community colleges, and private institutions (Participating Organizations). Known as the Entry Level Welder Training Program (ELWTP), its establishment in 1995 was based on a survey of industrial and educational representatives. The total cost of approximately one million dollars was funded jointly by the U.S. Department of Education (49%) and the AWS (51%).

Students who successfully complete the training program are entered into an AWS database known as the National Registry of Entry Level Welders. The September 1997 Registry contained the names of 118 graduates of the program. Participating Organizations, qualified to offer the training, numbered 251 as of September 1997. These 251 organizations and the 118 graduate welders comprise the two populations of this study.

The fundamental need for such a program was based on a lack of uniformity in training procedures for welders and the requirement for recertification when welders transferred from one employer to another. Several writers, through dissertations and journal articles, have indicated the need for training and study in welding occupations. The development of new techniques, material utilization, and global markets further enforces the need for this continued upgrading of welding technology. The History of Welding, dating back more than 2000 years, illustrates the extensive changes that have occurred and the probability of continued changes in the future. The technology required to meet these changes translates to more and better training programs such as this study attempted to evaluate. The establishment by the AWS of the ELWTP provided the opportunity for this study. A program such as this, requiring 1200 hours of welder training to complete and costing one million dollars of taxpayer money, seemed an appropriate subject of investigation. The requirement of new skills and knowledge for welders, both experienced and future, will apparently continue.

This study has been made to determine which courses and learning objectives of the ELWTP should be increased or decreased in accordance with the continuing search to improve training programs. This study will contribute to the improvement necessary to maintain the level of training required in welding technology. An evaluation of the ELWTP will provide the AWS with a basis for upgrading the program and maintaining the welder certification database. This upgrading will eventually benefit the welders, educators, industry, and society.

CHAPTER 2

LITERATURE REVIEW

Introduction

The review of literature presented here consists of two major areas: a) review of publications, and b) welding education. Although the literature search can be used to locate new or related research topics, the major purpose, according to Gay (1992), "is to determine what has already been done that relates to your problem" and "the review of related literature involves the systematic identification, location, and analysis of documents containing information related to the research problem" (p. 38). Both manual and computer searches were conducted for this study. In addition, bibliographies and reference lists from other publications were examined and utilized in some cases.

Review of Publications

Most training evaluation studies involve a pretest and posttest of the students involved. In the present study, all data were collected after the students had completed the required curriculum and had entered the workplace. None of the students knew of this forthcoming evaluation when they completed their training. Their opinions were solicited by asking for personal evaluations of all areas of the training program after they had successfully completed it, and their names were included on the National Registry of Entry Level

Welders. The literature search revealed no studies in which students trained in welding had been contacted only after completion of a formal training program to provide information about the curriculum.

Only a few doctoral dissertations or similar studies were found which were specifically related to the topic of this study. However, many papers involving evaluation methods, evaluation of training programs, and the training needs of welders were located. Selections from these sources were condensed and summarized in an attempt to illustrate the varied opinions which exist concerning what should be offered in the training curriculum for welders. The need for trained welders was also indicated in some of these articles.

One of the earliest studies involving training requirements for welders was a doctoral dissertation by Morgan (1968). Morgan referred to a doctoral study by Donald E. Maurer (1966) which indicated that the "welding industry is experiencing a period of intense development" (p. 17). Morgan's literature review found this to be the only doctoral dissertation which dealt with welding technology. The purpose of Morgan's study was, in part, to ascertain the nature of the occupational preparation desired for welding tradesmen. His data were collected through a questionnaire distributed to members of the American Welding

Society (AWS) who represented industrial companies engaged in extensive welding fabrication. He concluded that "a great need exists for welding technicians and technologists to receive pre-employment preparation in those areas represented by the items classified as related information" (p. 4). His study was based on the opinions of industrialists without contacting any welding tradesmen. Morgan recommended that further research should be conducted to ascertain the level of skill desired in pre-employment preparation of welding tradesmen.

Jones (1978) developed a model for evaluation of employee training programs, for a doctoral dissertation at Cornell University, by extensively reviewing existing models and building on them. He pointed out that the most difficult aspect of evaluation to measure is behavior or performance. His findings also revealed that limiting factors in evaluation were lack of appropriate standards, expertise, and resources. Since behavior is the most important area of measurement and also the most difficult to measure, it may be distorted when employees modify their behavior because of the presence of an observer. Jones concluded that the use of scales and other rating forms may be the best approach to quantifying behavior. He felt that most designs for evaluation were inadequate. Many people feel threatened by evaluation systems and a way of reducing this perceived threat is to involve the people who are being evaluated. This concept will be used, in part, to develop the study of Entry Level Welders to be presented here.

Another related study by Papritan (1985 a & b) titled The Trends of Welding Training in Vocational Education was similar to those by Morgan (1968) and, subsequently, Helzer (1986). Papritan's study of trends in welding training consisted of populations of 250 welding educators and 250 welding industrialists with responses of 139 (55%) and 135 (54%) respectively. As in other studies, no welding tradesmen were contacted. The investigation by Papritan attempted to identify both current and future training needs of welders. His study also used the Borich Needs Assessment Model (Borich, 1980) utilized by Helzer. Papritan divided the study into two parts: (a) components of the welding curriculum and (b) joining (welding and brazing) and severing (cutting) processes. The subjects were ranked and analyzed by means of the Spearman Correlation Coefficient. This coefficient was 0.73 for current needs and 0.74 for future needs of welding training. This degree of correlation indicates that "educators and industrialists generally agree (if not always specifically) on current and future welding training needs" (p. 26). Papritan's publication does not include an example of the questionnaire nor does it give the raw data and calculations. His recommendations for the first part (Welding Curriculum) for increased areas of welder training were divided into current and future curriculums. Current recommendations were in the areas of (a) Computer Literacy and (b) Welding Certification. Future recommendations also call for increased training in these two areas plus (c) Welding Codes, (d) Weldment Preservation, (e) Metallurgy, (f) Welding Applications, (g) Heat Control, and (h) Blueprint Reading. These are subjects that both educators and industrialists feel should receive increases in the amount of training provided. The second part of Papritan's study (Joining and Severing Processes) also contains several recommendations. Recommendations for increased training which are common to both current and future welding processes include the areas of Robotic Welding, Electron Beam Welding, Laser Beam Welding, and Plasma Arc Cutting. In summary, Papritan listed five specific items which should be included in each welding curriculum. He concluded that enhanced training should be provided in areas currently in demand and those which will be required in the future.

One of the few doctoral dissertations found, which is closely related to the topic of this study, was written by Helzer (1986) titled Current Practices and Future Trends in Pre-Employment Skill Requirements for Welding Technologists. A questionnaire was developed and sent to educators and industrial representatives. Although the study investigated skill requirements for Welding Technologists, they were not asked for any input. Convenience samples of 60 educators and 45 welding industrialists were selected with a usable response rate of 40% (24) and 58% (26) respectively. Helzer's dissertation used the Borich Needs Assessment Model (Borich, 1980) for analyzing discrepancies between current and future trends. Correlation coefficients were calculated using the Pearson Product Moment Correlation Coefficient. Helzer's conclusions about current practices indicated "a definite mismatch exists between industry demands and current educational practices" and "educators were not teaching students for one specific highly specialized area of technology; but, they were training students to perform in a number of occupations related to the field" (p. 48).

Concerning future trends, Helzer (1986) concluded "there is a much higher level of agreement between educators and industrialists in this area as reflected by the correlation coefficient of .703" (p. 48). The correlation coefficient between the groups based on current practices was only .234 indicating a "very weak association" (p. 48). Some of the areas of training for welding technologists which need to be increased were described as plasma arc, pulsed gas metal arc, laser beam, and electron beam. Helzer continued by recommending that students be involved in real life situations as well as text book instruction for the new advanced welding processes. It seems reasonable that, if these suggestions are applicable to welding technologists, they would also apply to welders who are actually involved in production work. Helzer's recommendations for further studies have, in some instances, been realized over the past ten years. The AWS survey, and subsequent Entry Level Welder Training Program (ELWTP), are responses related to his recommendations. The study presented here is based on evaluating the AWS program which was eventually developed.

Several schematic algorithms were presented by Sage and Rose (1986) for analysis and content determination of welding training programs. They offered the opinion that instruction should be designed to improve human performance and attention should be focused on skills required in job performance. A systematic approach is outlined to accomplish these goals. One of the major processes in this approach is to "evaluate and revise the training program, instructional materials and/or training aids to maximize employee competence and on-the-job performance" (p. 18). The present study will contribute to this "evaluate and revise" process. An interesting point made by Sage and Rose concerns the "assessment of need." They felt many training programs were based on requests from company officials rather than by identification of training needs through basic research. The basic research contributed by this study will, it is hoped, alleviate that type of bias. They concluded by observing that the analysis of work behaviors is one of the most powerful ways of improving job performance of welding personnel. If analysis is properly performed, implementation and evaluation of instructional content will follow, resulting in an improved training program.

Miller (1991) pointed out that two factors contribute to the difficulty in recruiting productive workers in the welding trade. The first is the changing technology which requires employees to learn new skills and the second is the decline in literacy levels among students who do not complete high school. Some complaints about entry-level workers observed by Miller include slowness, poor craftsmanship, and low levels of endurance. Some of the techniques for effective welder training advocated by Miller were as follows:

1. Carefully explain the reasons for specific procedures.

2. Provide frequent performance feedback to trainees.

3. Use visual media and hands-on training as much as possible.

4. Utilize all three learning elements, i.e., cognitive, psychomotor, and affective.

5. Convince employees that they should keep up to date in their skills.

Miller concluded that OSHA and environmental groups would require familiarity and compliance with more regulations. This would result in an improved image of the welding trade through the development of motivated and efficient trainees.

Another doctoral dissertation by White (1991) at Texas A&M University evaluated training needs of manufacturing firms. This study involved personal interviews of key personnel from 29 manufacturing firms in the Bryan/College Station, Texas area although no tradesmen from the work force were included. One of the most significant findings of the study was the anticipated increase in the number of new employees needed in each of the following three years. Manufacturing employees and welders were included in the predicted high demand occupations. An interesting method of data presentation, the "Chart Essay" method, was used to summarize the various aspects of the study. This method is straightforward and easy to follow. The results indicated current and future shortcomings of specific occupational skills. The results also revealed that employers were willing to contribute to training programs if they applied to the needs of the industry.

A cross section of comments of Welding Journal readers was summarized and presented by Woodward (1993). These respondents offered suggestions as to the kinds of welding training the AWS should offer. Some ideas included more involvement with metallurgy, correspondence courses, safety, seminars, video programs, and computer literacy. One individual suggested that the AWS should provide educational standards, furnish accreditation, and provide certification and registration. Still another cited a need for courses in advanced problem-solving techniques such as genetic algorithms and neural networks. Most of these views were offered by industry executives, engineers, welding inspectors, and educators. No opinions were evident from any welding tradesmen.

Irving (1993) listed several advanced research activities as previously mentioned in Chapter 1. Federal agencies were offering help in several areas which would possibly require advanced or continued training of welders. Several well known companies such as Westinghouse, Pratt and Whitney, Boeing, and General Electric were involved in these research projects. Research leading to advanced welding techniques and methods will increase the demand for qualified welders. Education and training will produce tradesmen who can successfully compete in these new technologies.

Cullison et al. (1993) conducted a survey of 2500 (642 respondents, 25%) AWS members classified as welders or cutters. This one-page survey requested mostly demographic and general information in 15 different areas. Questions related to work title, wages, age, and education revealed very little about what welders wanted in terms of training. Additionally, a variety of employers were visited and interviewed to determine their views as to the need for welders and what is expected of them as employees. The authors' visit to the shipyards revealed that those employers "tend to be a training ground for welders" (p. 36). Entry-level welders are trained and certified to work to required specifications. Training may take from three days to six weeks to upgrade skills for welding stainless steel, Monec, copper-nickel, Inconel, and aluminum. Conclusions of the study revealed that the demand for welders has softened but that the highly skilled welder will always be in demand. Some respondents complained about low pay and lack of respect. However "most welders like the trade, find it profitable and creative, recommend it to others for a career, and are generally satisfied" (p. 42). Employers expressed concern about finding first class welders when needed. Workers are sometimes being cross-trained and having their skills upgraded to increase the number of available skilled welders in anticipation of improved future business.

Some points were made regarding the future of welding education in an article by Kjeld (1994). He felt that a critical labor shortage would soon occur in this country and that the training of future welders should start in the public school system. He also indicated that national standards should be established. Examples of teaching systems in foreign countries were offered to support his ideas. Kjeld also pointed out that there is more emphasis on earning a bachelors degree than on learning to work and that most new jobs in the next five years will not require a college degree. Additionally he suggested that welding programs be funded for a period of five years, that the image of welding needs improvement, and that nontraditional teaching methods be used. Kjeld concluded with the fact that reported welding technology programs decreased from 839 to 781 over a recent 10 year period and that the possibility existed for losing our welding technology much the same as we have lost our ability to manufacture camcorders, TVs and VCRs.

A recent letter issued to customers by Nucor-Yamato Steel Company (Johns, 1997) described the "enhanced" 50 ksi yield steel grade. The letter referred to a February 28, 1997 announcement by the American Institute of Steel Construction (AISC) which used the description "Improved Building Grade" with the ultimate intention of providing designers with a "well defined" 50 ksi steel. Since this revised grade is still in the American Society for Testing and Material's (ASTM) balloting process, there is no official ASTM "number" designation. Current conformance would be determined by comparing the new requirements to the mill test reports. Engineers, fabricators, and welders all need to be advised, and possibly upgraded, when new requirements such as these are introduced.

A vocational educational program for training welders was recently enacted in Jamaica through the combined efforts of two Rotary Clubs (Johnsen, 1997). This unusual pairing demonstrated how the combined efforts of private organizations could accomplish a positive educational objective. The two clubs solicited help from Miller Electric, Lincoln Electric, Ingalls Shipbuilding, AWS, and others for approximately $100,000 worth of equipment and supplies. Mississippi Gulf Coast Community College (MGCCC) provided training for the instructors and also donated over 2000 books which were transported by the U.S. Air Force. The entire Jamaican undertaking was an apparent example of innovative and nonconforming education in which both students and teachers have given each other high marks.

According to Irving (1997), basic research is declining in this country due, in part, to a reduction in defense-oriented funding. Apparently, most of the basic research has been conducted by universities and it is this area that primarily affects the welding industry. One solution to the problem of basic research funding appeared to be collaborative efforts among institutions. Irving's interview with Glen R. Edwards, the director of the Center for Welding, Joining, and Coatings, at Colorado School of Mines (CSM) revealed that at least $60,000.00 per year per student is required to run a graduate program. CSM was involved in one study involving arc-welding of high-strength steels and another involving laser welding. Edwards further indicated that there was no support for long-range basic research although he felt there is a great need for research in aluminum welding.

The American Welding Society (AWS) has a variety of committees such as Education, Certification, and Qualification which are active in the development and support of an extensive array of activities. A survey of public school educators is currently being conducted by the Education committee to determine their needs regarding welding education. Preliminary results indicated the educators were looking for computer based programs. This survey, when complete should produce interesting results and many new projects (AWS Needs You, 1997). The AWS solicits volunteers who have an interest in welding education to become active in current and future projects.

Welding Education

Education of welding tradesmen and professionals consists of a variety of formal and informal courses, seminars, and workshops. These various types of training are offered by public and private schools, professional organizations, government, military, penal institutions, and industry. Many welders have received little or no formal training and may have been largely self-educated, served an apprenticeship, or had the trade passed from father to son. Although informal training techniques have been adequate in the past, new technology does not permit this slow, one-to-one method of learning. Today's and tomorrow's requirements will involve higher levels of customized and specialized training.

The Lincoln Electric Co.(1995) offered a variety of arc welding courses covering all phases from the elementary basics to advanced. Their brochure described the training facility as the "oldest in the nation" (p. 2). Course descriptions include Basic Plate and Sheet Metal which is five weeks in length (approximately 150 hours) at a cost of $760.00. Other courses such as pipe welding, hardfacing, robotics, and innershield are described with costs from $220.00 (one week) to $450.00 (two weeks). Class sizes are limited to 15 students with approximately 90% of the time spent on actual welding, exclusive of group instruction.

Qualification tests for AWS (structural) code work are available with the cost of testing ranging from $140.00 to $220.00 paid directly to an independent testing laboratory. The brochure also explains the refund policy, opportunities for room and board, and type of diploma awarded.

The Hobart Institute of Welding Technology (1997) has trained over 75,000 people since it was founded in 1930 (p. 4). The Institute offers education and training in welding technology, distributes educational materials, and conducts related welding research. Training consists of lecture, discussion, audio-visual, demonstrations, and individual practice followed by practical and written testing. Instructor to student ratios vary from 1:12 to 1:18; course lengths from 34 weeks to 1 week; course costs from $7845.00 to $425.00. Qualification and certification procedures are available to meet a variety of specifications and codes. The Hobart Institute offers an impressive selection of welding courses, as well as training in non-destructive testing techniques such as liquid penetrant, magnetic particle, and ultrasound. Video-based training programs are available complete with instructor's guides, workbooks, and comprehensive tests. The Institute has been accredited by the AWS under the Certified Welder Program.

Another manufacturer offering training materials in the welding field is Miller Electric Manufacturing Co. They offer a variety of packaged do-it-yourself programs including texts, videos, and home study literature. Welding courses and custom-designed seminars are also available at their corporate headquarters.

Summary

The review of related literature has identified several publications which point to the need for additional studies in the field of welder training. Only a few doctoral theses were located which specifically involved studies of welding related training; namely Morgan (1968) and Helzer (1986). A number of articles discussed the problems facing future welders related to new materials being developed. Others pointed out the need for vocational programs and associated welding training. Research was indicated by several writers but according to Irving (1997), basic research is declining.

References to changing technology and advances in high strength steels, (Helzer, 1986) and, more recently, the development of the enhanced 50 ksi yield steel indicate the need for continued welder training to meet these and other requirements. Importance should also be attached to the possibility of losing our welding technology (Kjeld, 1994) and remaining competitive in global markets (Murray, 1997). The training methods necessary for the welding industry to remain competitive will be enhanced through this study by identifying areas in the ELWTP which, in the opinion of educators and welders, need to be revised.

Most studies related to welder training have involved opinions from the fields of education and industry. With the possible exception of a study by Cullison et al. (1993), no research has been evident which included the opinions of welding tradesmen. According to Borich (1980) "training institutions search continually for ways to improve their training programs" and "perhaps the most frequently used method has been the follow-up questionnaire mailed to recent graduates to elicit their opinions about the training they received" (p. 39). However, the review of literature for this study produced no such types of evaluations for graduates of welding programs. That such a study is necessary is evident from the suggestions and opinions offered in the literature review.

The education of welders has progressed considerably from the father-to-son and apprenticeship methods of the past to the sophisticated techniques currently used in our educational system. This study will provide information to the American Welding Society, public school systems, and private training classes which will assist in upgrading the content of all programs, including the ELWTP. The future can only bring an increase in the demand for skilled welders. The ELWTP with its training and certification programs, will greatly assist the industry in meeting that future demand.

CHAPTER 3

DESIGN AND METHODOLOGY

Populations

This study was undertaken to identify possible revisions required to the American Welding Society (AWS) Entry Level Welder Training Program (ELWTP). The results of the study could be of use to the AWS in future curriculum analysis. Educators may find the results helpful in course planning and students will be able to identify the types of training considered important by graduate welders.

Two groups comprised the research population for this study. The first group consisted of faculty members who actually taught the course at registered participating organizations, institutions accredited by the AWS to offer the curriculum. The second group consisted of all graduates of the program registered as Certified Entry Level Welders. A listing of each group, as of September 1997, was furnished by the AWS. There were 118 (117 with addresses) Certified Entry Level Welders and 251 (250 with addresses) registered institutions (faculty) on these two lists. This resulted in a total of 367 questionnaires being mailed out originally, for both populations. The geographical dispersion of the faculty members involved institutions in 39 states, plus the country of Peru, from Alaska to Florida and California to New York. Many of the institutions have been accredited for only one or two years and may have few, if any, welders who have successfully completed the training.

Survey Instrument

A questionnaire was developed based on the curriculum guidelines presented in AWS EG2.0-95, Guide for Training and Qualification of Welding Personnel-Entry Level Welders. It is an AWS publication for assisting training institutions in the development and administration of the ELWTP. The manual contains sections on curriculum and qualification guidelines as well as recommendations for faculty planning, materials, equipment, and tools. These guidelines direct the institutions in providing competency-based training that leads to the certification of trainees in accordance with AWS specifications. The questionnaire consisted of 65 topics which follow the learning objectives suggested in the guide. The learning objectives, as provided by the AWS, were divided into six courses as follows:

No.	Course
1.	Occupational Orientation
2.	Drawing and Welding Symbol Interpretation
3.	Arc Welding Principles and Practices
4.	Oxyfuel Gas Cutting Principles and Practices
5.	Arc Cutting Principles and Practices
6.	Welding Inspection and Testing Principles

Each of these courses was then further divided into learning objectives as outlined in the AWS guidelines. Respondents (faculty and graduates) were asked to evaluate each learning objective. A five-point Likert scale was provided for this comparison. Page 16 of AWS EG2.0-95 provides the basic outline of the ELWTP competency based program with courses, units, and learning objectives. These courses are further described in greater detail, with learning activities and evaluation criteria on pages 19 through 87. Finally, Annex E includes 10 pages of training achievement records whereby each of the 65 learning objectives is given a performance rating and signed by the instructor. The questionnaire for this study was derived directly, with only minor abbreviations, from the foregoing outline and performance record. The justification for using the guides established by AWS EG2.0-95 was further reinforced by AWS QC 10-95, section 3, reproduced as follows:

> 3. Requirements for Participating Organizations
>
> 3.1. Participating Organizations may be training-and-testing or testing-only facilities.
>
> 3.2. Participating Organizations shall maintain and follow a quality manual that assures compliance with this specification.
>
> 3.3. An application for registration as a Participating Organization shall be submitted with a cover letter signed by the Senior Official at the Facility. The cover letter shall certify to AWS that

the Facility has a Quality Program which will be rigorously followed, and that the requirements of this standard will be met. If the Participating Organization is a training-and-testing organization, the letter shall also state that their curriculum follows AWS EG2.0, Guide for Training and Qualification of Welding Personnel - Entry Level Welders.

3.4. Test supervisors for testing-and-training or testing-only Participating Organizations should be AWS Certified Welding Inspectors.

3.5. Instructors for testing-and-training Participating Organizations should be AWS Certified Welding Educators.

3.6. Quality System Audits. Audits may be required if evidence of nonconformance with the Participating Organization's Quality Program or this specification exists. (p. 2)

Identical questionnaires were sent to each population (faculty and welders) although the accompanying cover letters were slightly different. For instance, the faculty cover letter requested that the questionnaire be forwarded to an instructor who had actually participated in the ELWTP teaching process rather than a principal, superintendent, or administrator. Each cover letter was individually addressed to both populations on University of Northern Iowa letterhead and individually signed to improve the response rate. Dillman (1978) recommended this and other techniques as a means of increasing the return rate. The cover letter to the welders included a dollar bill for coffee, soft drink, or candy bar. The original mailout packages were mailed in 9 x 12 envelopes with neither the cover letter nor the survey instrument being folded. This method was not suggested in any of the literature review. However it was the writer's feeling that an unfolded paper lying on a desk or table would draw more attention and increase the probability of a response. Other suggestions by Dillman were incorporated into the questionnaire and cover letter as follows:

Colored stationery

First class mail, to and from

Inclusion of stamped return envelope

Expressed confidentiality of returns

Reasonable explanation of the subject

Benefits of the study

Dillman pointed out that research concerning which techniques actually increase response rate has not been conclusive by quoting Kanuk and Berenson:

> Despite the large number of research studies reporting techniques designed to improve response rates, there is no strong empirical evidence favoring any techniques other than the follow-up and the use of monetary incentives. (p. 7)

Many of Dillman's suggestions were paralleled by Norman (1948), particularly his contention that "Follow-ups in general increase the percentage of return, as do simple rewards" (p. 245). Follow-ups and rewards were both used in the methodology employed here. Norman also made the point:

> Those who respond to a mail questionnaire have been found, almost universally, to differ radically from those who do not reply. It is probable that late respondents also differ from early respondents. (p. 248)

A copy of the questionnaire, with cover letters, is included in Appendix E. The final versions of the questionnaire, as mailed, were reduced to four pages by using condensed printing, although the format and content were not changed. The four pages were then reproduced on one 11 x 17 sheet and folded into a booklet form to give a neater, less formidable appearance.

Validation

The survey instrument was submitted to four experts in the field of welding training for evaluation. The four were selected on the basis of published works, membership on the AWS education committee, and familiarity with the ELWTP. The first round of submittals produced a number of recommendations from the four experts as well as suggestions from committee members. The questionnaire was then revised to include the five-point Likert scale which was eventually mailed to both populations. The four experts are identified in Appendix C.

Further validation was provided by requesting three experienced certified welders to complete the questionnaire. The results of their efforts suggested that the questionnaire could be completed in approximately 15 minutes. Although none of the three had participated in the ELWTP, their extensive experience was considered valuable enough for the objective under consideration. The approximate length of time required for completion (15 minutes) was also noted in the cover letters.

Follow-up Procedure

Several methods for establishing a follow-up system to increase response rate have been suggested. Dillman (1978), discussing his Total Design Method (TDM), offered the following statement concerning follow-up mailings:

> Without follow-up mailings, response rates would be less than half that normally attained by the TDM, regardless of how interesting the questionnaire or impressive the mailout package (p. 180).

Dillman's suggested three-step method follow-up procedure is as follows:

One week: A postcard reminder sent to everyone. It serves as both a thank you for those who have responded and as a friendly and courteous reminder for those who have not.

Three weeks: A letter and replacement questionnaire sent only to nonrespondents. Nearly the same in appearance as the original mailout, it has a shorter cover letter that informs nonrespondents that their questionnaire has not been received, and appeals for its return.

Seven Weeks: This final mailing is similar to the one that preceded it except that it is sent by certified mail to emphasize its

> importance. Another replacement questionnaire is enclosed (p. 183).

Dillman's method was used as a guideline in developing a follow-up method for this study. Waiting seven weeks for the final mailing (possibly two more weeks for the returns) seemed too long particularly in view of the extensive holiday season. Since the first mailing occurred on November 20, 1997, the following week included the Thanksgiving holiday. It was felt that this holiday event would influence the response rate, particularly from faculty members. In some cases, educators might not have an opportunity to see the questionnaire until the following week. In view of this it was decided to wait until December 10 before sending out the first follow-up. This would give faculty members an opportunity to complete the instrument before final exam week. Because of the Christmas holiday and subsequent four-week break, no further follow-up procedures were attempted. The final response was received January 27, 1998 approximately nine weeks after the first mailing.

The follow-up procedure was similar to that used by Swanson (1989). His survey of 226 industrialists and educators produced an original response rate of 33%. A follow-up postcard sent 10 days later resulted in an additional 14% for a total return rate of 47%. This conformed to his original determination of an acceptable rate of 45%. Schultz (1991), in a similar dissertation questionnaire, surveyed 204 supervisors and 265 educators. Return rates were 39.22% and 26.04% respectively. The combined rate for the total of 469 mailings was 31.77%. According to McCallon and McCray (1975), "members of low educational groups tend not to respond to questionnaires at all" (p. 12). Based on this concept and the response rates accepted in the previous dissertations, similar rates of return were expected in this study.

The follow-up methods used in this study consisted of postcards mailed to welders and letters faxed to faculty members. The decision to fax reminders to educators was also influenced by final exam week and the upcoming Christmas break. Because of the university shutdown, no mail returns were available during the holidays. Only a few of the responses due to reminders came in before the shutdown. Therefore, it was decided to use the first week of January as the cutoff point for receiving questionnaires.

Analysis

A computerized statistical package, SAS/STAT User's Guide (1990), was used for analyzing the Likert Scale data from the returned questionnaires. Statistical t-tests for two independent populations were used to compare welders and faculty members at the .05 level of significance. The values were calculated for the six ELWTP Courses (Table 1) and also for the 65 Learning Objectives (Tables 2 through 7). The Effect Size (ES), according to Cohen (1977), was also calculated when applicable. These tables display the mean, standard deviation, t, and p. The ES is indicated in the accompanying text.

Rank order tables (largest to smallest) were also constructed for the mean response values of the 65 Learning Objectives. Tables 8 and 9 list the rankings for welders and faculty members, respectively. Table 10 lists the rankings for both welders and faculty for comparison purposes.

The final statistical presentation is offered in Appendix H. A table has been constructed for each of the six ELWTP Courses. These tables show the percentage of responses for each Likert Scale response. Welders and faculty members are listed together in each table to facilitate comparison of the groups.

Summary

All of the foregoing techniques were used in hopes of obtaining an adequate number of responses. This subject was discussed with the author's graduate advisory committee to arrive at an estimated return rate. Based on the unusual populations involved, it was suggested that a return of 20% for welders and 40% for faculty members would be rates that would likely be obtained. In a personal communication with

Robert V. Reeve (1998, January), AWS Director of Education, he indicated an approximate response rate of 20% for the original survey conducted to establish a basis for the ELWTP. Norman's (1948) study of 12 authors reported return rates varying from 15% to 76%. Some reasons for such wide variations were indicated by various authors:

1. Recipients do not wish to be annoyed with a long questionnaire. (p. 239)

2. Faculty members were not likely to answer if they held a minor position of one-year tenure. (p. 240)

3. Higher intelligence scores were associated with a positive tendency to respond. (p. 242)

4. Under certain conditions, people in the higher income and educational brackets will return mail ballots with consistently greater frequency. (p. 243)

All of the foregoing reasons could apply to the populations of welders and faculty used in this study. Other factors mentioned which influence questionnaire return dates were "interest, conscientiousness, promptness, time available, pleasurable associations with the source of the questionnaire, sufficient lack of embarrassment with one's present status to be willing to report that status, and many other factors" (p. 242).

It is suggested that researchers avoid conducting surveys of this type during holidays and periods of academic breaks. The possible absence of respondents and overall university shutdown combine to interrupt and delay the progress of the study.

CHAPTER 4

PRESENTATION AND ANALYSES OF DATA

Introduction

Data were collected, presented, and analyzed through a questionnaire mailer returned from two populations: (a) welders and (b) faculty members. Both populations were obtained from the American Welding Society (AWS) and consisted of welders who had successfully completed the AWS Entry Level Welder Training Program (ELWTP) and faculty at institutions authorized to offer the ELWTP. The questionnaire consisted of 65 items to be evaluated by a five-point Likert Scale. The 65 items consisted of Learning Objectives required by the AWS ELWTP curriculum. The items were analyzed using a two-tailed t-test for independent means at the 0.05 level of significance. This is based on examination of other, similar, dissertations and Cohen (1977):

> The .05 significance criterion, although unofficial, has come to serve as a convention for a (minimum) basis for rejecting the null hypothesis in most areas of behavioral and biological science. (p. 12)

Each item (Learning Objective) was tested to compare the two populations to determine if a significant difference existed between the means. A table was also constructed to display the percent of responses in each of the five possible Likert Scale choices. Rank-order tables were also constructed for each population based on the response means. In addition, the two populations were compared by rank-order in another table.

Response Rate

The original population lists furnished by the AWS consisted of 118 welders and 251 institutions (faculty). Several of each population either had incomplete addresses or the questionnaires were returned as being undeliverable. Because of this the number of possible respondents was reduced to 108 welders and 249 faculty. Responses consisted of 48 (44.4%) welders and 114 (45.8%) faculty members. Two of the welders' questionnaires were received after the cutoff date, reducing the usable number to 46. Six of the faculty respondents indicated that their training institutions were not currently using the ELWTP and nine were received after the cutoff date reducing the number of possible returns to 243 and those considered usable to 98. A number of respondents, both welders and faculty, did not provide answers to all of the questions either through neglect, oversight, or misunderstanding. In those cases, the mean was calculated based on the number of usable responses.

The list of institutions furnished by the AWS included both training facilities and testing facilities (two separate entities). This was not known at the time of the original mailing and only became evident from some of the responses. Subsequent conversations with the AWS revealed that they had no practical way of identifying which facilities offered testing services only. If an arbitrary assumption of five percent was used, the 251 training facilities would be reduced to 226. Obviously, replies to evaluate training could only come from these organizations. Under such circumstances, the true response rate is virtually impossible to calculate. However, the rates achieved were well within the acceptance rates discussed in Chapter 3.

Many of the returned questionnaires included comments, suggestions, and full page letters. Some contained business cards or brochures outlining the training programs. Several faculty members called to discuss their views although none called collect as was suggested in the questionnaire. Two of the welders returned the enclosed dollar bill and many wrote a thank you for coffee money. Both welders and faculty, in some instances, signed their full names and addresses to the questionnaires, indicating they had no desire to remain anonymous. Although most of the usable questionnaires appeared to be completed conscientiously, several were returned with all number threes of the Likert Scale "Leave As Is" indicated. This might be interpreted as indifference or, possibly, a complete satisfaction with the entire program.

The questionnaires were mailed out on November 20, 1997. The first mail return was received on December 2, a turn-around time of 12 days including the Thanksgiving holiday. However, two were sent to Peru and those were actually received first by FAX. The fact that many were returned without the postmark being cancelled challenges the reliability of the U.S. Postal Service. It is possible that some questionnaires were lost in the system, either by outbound mail or when returned. According to the postmark dates, some required as many as 18 days to be returned. In one instance, the original questionnaire was completed and returned by a welder after the follow-up postcard had been returned as "undeliverable." Many respondents elected to pay their own postage and return the questionnaires directly to the author. This may have been due to losing the original return envelope or personal preference. Mail returned to the university could also affect the response rate due to the fact that it must again be handled several times.

Respondent Comments

The questionnaire included a space for both welders and faculty to add their respective comments. Welders added comments to 17, (37%) of the 46 usable returned questionnaires. Faculty members commented 37 times for a rate of 37% based on the usable returns. Some returns were personally signed, some contained business cards, and others included full page letters. The explicitness of these comments ranged from major disagreement with the ELWTP to profuse thankfulness for the opportunities provided. The comments included here have been reproduced nearly word-for-word except for minor editing and condensing to protect the respondent's identification as agreed in the original cover letters. The comments have been included in Appendix G. They are separated according to welders and faculty but are listed in no particular order.

Data Analysis

The two populations, welders and faculty members, responded to a questionnaire consisting of six training courses which were further divided into 65 Learning Objectives. The course content of each of the 65 Learning Objectives was evaluated by means of a five-point Likert Scale as follows:

Value	Interpretation
1.	Decrease Considerably
2.	Decrease Slightly
3.	Leave As Is
4.	Increase Slightly
5.	Increase Considerably

A mean value of 3.0 indicates that the respondents would prefer to leave the course content as it is currently offered or presented. Mean values less than 3.0 imply that the course content should be decreased and, conversely, means greater than 3.0 imply that the course content should be increased. Since the Likert Scale is discrete rather than continuous, respondents did not have an opportunity to select decimal values between one and two, two and three, etc. Therefore, values midway between the Likert Scale values have been used as dividing points. Tables 1 through 7 display the mean, standard deviation, *t* statistic, and probability, *p*. The Effect Size, ES (difference in means divided by the base standard deviation), is given when the value of *p* is less than .05.

All of the mean values in Tables 1 through 7 for both welders and faculty lie in the middle range of the Likert Scale. They have been interpreted following Schultz (1991), according to the divisions indicated below:

Mean	Interpretation
1.5-2.49	Decrease Slightly
2.5-3.49	Leave As Is
3.5-4.49	Increase Slightly

None of the items in Tables 1 through 7 received mean evaluations to indicate that the course content should be "Decreased Considerably" or "Increased Considerably."

Descriptive statistics for the six courses are presented in Table 1. The means for welders and faculty were compared using t-tests for two independent populations at the .05 level of significance. Statistical values of *t* and *p* are also displayed in Table 1. Computations were made using the SAS statistical software which performs a two-sample, two-tailed, t-test for testing the hypothesis that the two means are equal. The probability, *p*, determines whether the difference in means is significant at the .05 level. Values of *p* equal to or greater than .05 indicate no significant difference. Values of *p* less than .05 indicate a statistically significant difference. The Effect Size (ES) has been calculated for *p* less than .05 by dividing the difference in means by the standard deviation of the faculty members' responses. Faculty members were selected as a base for choosing the appropriate standard deviation. The values of ES, then, represent the size of the difference in terms of standard deviation units.

According to Cohen (1977), "the power of a statistical test of a null hypothesis is the probability that it will lead to the rejection of the null hypothesis" (p. 4). He has constructed tables giving the relationship between power, effect size, significance criterion (.05), and sample size (*n*). When the sample sizes are unequal, Cohen suggests using the harmonic mean (p. 42):

$$n' = \frac{2n_1n_2}{n_1+n_2}$$

Sample sizes for welders and faculty of 46 and 98, respectively, yield an n' value of 63. Cohen also offers his relative definitions of Effect Size, ES, (p. 40) as follows:

Small ES = 0.2
Medium ES = 0.5
Large ES = 0.8

These are supplied as "a common conventional frame of reference which is recommended for use only when no better basis for estimating the ES index is available" (p. 25). Using a medium ES of 0.5 and n = 63 at a significance level of .05, Cohen's tables yield a power value of .79 (p. 36). The power value of .79 is also supported by Cohen's suggestion, "it is proposed here as a convention that, when the investigator has no other basis for setting the desired power value, the value .80 be used" (p. 56). Cohen's method supports the t-statistics which indicate significant differences between welders and faculty.

Five of the six ELWTP courses, as illustrated in Table 1, have p values less than .05 implying that the null hypothesis should be rejected. Moreover, the implication is that there is a difference between the means. Only Course A. Occupational Orientation indicates agreement between the welders and faculty members. Courses B., C., and F. are significantly different in Cohen's "medium" range and Courses D. and E. are significantly different in the "large" range. The calculated "Power" value of .79 corresponds to Cohen's suggested value of .80 which is the probability that the null hypothesis will be rejected. This applies to five of the six courses in Table 1 which is a percentage of 83%.

Table 1

Statistics for the Six ELWTP Courses

Course	Group	Mean	SD	t	p	ES
A. Occupational Orientation	Welders	3.37	.38	1.39	.17	
	Faculty	3.27	.46			
B. Drawing and Welding Symbol Interpretation	Welders	3.74	.65	2.20	.03	.39
	Faculty	3.49	.64			
C. Arc Welding Principles & Practices	Welders	3.45	.33	3.12	.00	.55
	Faculty	3.23	.40			
D. Oxyfuel Gas Cutting Principles & Practices	Welders	3.40	.42	3.78	.00	.72
	Faculty	3.14	.36			
E. Arc Cutting Principles & Practices	Welders	3.62	.47	5.10	.00	.89
	Faculty	3.20	.47			
F. Welding Inspection & Testing Principles	Welders	3.63	.69	2.14	.03	.38
	Faculty	3.37	.69			

Note. *n* Values: Welders = 46.
Faculty = 98.

Further analysis of Table 1 indicates that the mean values for all six courses (both welders and faculty) are between three and four. If values between 2.5 and 3.49 are considered to indicate that the course content should remain as it is, then values above 3.5 would indicate that the course content should be increased slightly. Only Course B. Drawing and Welding Symbol Interpretation could be considered to be selected by both welders and faculty to "Increase Slightly." Courses A., C., and D. would then receive an evaluation of "Leave As Is" by both welders and faculty. Courses E. and F. were rated "Leave As Is" by the faculty and "Increase Slightly" by the welders. None of the courses were evaluated as needing a reduction in course content by either the welders or faculty.

The following six tables (Tables 2 through 7) present the descriptive statistics for the Learning Objectives included in each of the ELWTP courses. As with Table 1, Tables 2 through 7 have the mean values interpreted to evaluate course content as follows:

Mean	Interpretation
1.0	Decrease Considerably
2.0	Decrease Slightly
3.0	Leave As Is
4.0	Increase Slightly
5.0	Increase Considerably

Table 2 displays the statistics for the five learning objectives of Course A. Occupational Orientation. Only Item 2 has a *p* value less than .05, indicating a significant difference in the means. All of the mean values, except one, lie in the 2.5 to 3.49 range which equates to an evaluation of "Leave As Is." Learning Objective number five, relating to "follow written details," received a mean rating of 3.52 and this was only by the welders. Table 11 also indicates that Learning Objective number 5 has 41% of the welders favoring "Increase Slightly" compared to only 34% of the faculty.

Table 2

Statistics for Learning Objectives

Course A. Occupational Orientation

Item No.	Learning Objectives	Group	Mean	SD	*t*	*p*	ES
1.	Follow safe practices	Welders	3.33	.67	-.28	.78	
		Faculty	3.36	.61			
2.	Prepare time or job cards, reports or records	Welders	3.27	.82	3.24	.00	.77
		Faculty	2.83	.73			
3.	Perform housekeeping duties	Welders	3.33	.56	.39	.70	
		Faculty	3.29	.59			
4.	Follow verbal instructions complete work assignments	Welders	3.41	.62	-.22	.83	
		Faculty	3.44	.69			
5.	Follow written details to complete work assignments	Welders	3.52	.66	.91	.36	
		Faculty	3.42	.62			

Table 3 (Course B. Drawing and Welding Symbol Interpretation) has two *p* values less than .05 which indicates disagreement between the welders and faculty.

Items 6 and 7 have welders requesting that the course content be "Increased Slightly" whereas the faculty wants them to remain as is. Item 8 (Fabricate parts from a drawing or sketch) has mean values greater than 3.5 for both welders and faculty indicating a slight need for the course content to be "Increased Slightly." It also has a *p* value greater than .05, indicating agreement between the groups. This is supported by Table 10 (Comparative Rank Order) which indicates that both welders and faculty assigned a number one ranking to Item 8. Table 12 (Percentage of Responses) shows that for each Learning Objective the welders have considerably higher percentages favoring "Increase Slightly" than faculty members.

Table 3

Statistics for Learning Objectives

Course B. Drawing and Welding Symbol Interpretation

Item No.	Learning Objectives	Group	Mean	SD	*t*	*p*	ES
6.	Interpret basic elements of a drawing or sketch	Welders	3.67	.73	2.09	.04	.37
		Faculty	3.41	.70			
7.	Interpret welding symbol information	Welders	3.74	.77	2.34	.02	.43
		Faculty	3.44	.69			
8.	Fabricate parts from a drawing or sketch	Welders	3.80	.86	1.32	.19	
		Faculty	3.61	.79			

Table 4 (Course C. Arc Welding Principles and Practices) lists 31 Learning Objectives (items 9 through 39). All of the faculty members' means were in the "Leave As Is" category, indicating satisfaction with the current program. Welders selected 10 Learning Objectives to have the course content "Increased Slightly" and the remaining to "Leave As Is." All four of the Learning Objectives for welding aluminum and stainless steel were chosen for increases (Items 36, 37, 38, and 39). The Learning Objective "make minor external repairs" occurs in several of the courses and units. This was selected on four separate occasions (Items 10, 17, 25, & 31) by the welders to have the course content "Increased Slightly." Welders ranked all four of these items in the top 22 of the 65 Learning Objectives according to Table 8 (Rank Order). Faculty members ranked them all below the top 24 according to Table 9. Thirteen of the 31 Learning Objectives in Table 4 have p values less than .05 for which the Effect Sizes (ES) have been calculated. Four ES values would be considered "large" according to Cohen (1977) and the remaining nine would be considered "medium." These are displayed in Table 4 with the appropriate p values. Table 13 (Percentage of Responses for Each Likert Scale Item) indicates that the majority of welders and faculty have selected all Learning Objectives to be rated "Leave As Is."

Table 4

Statistics for Learning Objectives

Course C. Arc Welding Principles and Practices

Item No.	Learning Objectives	Group	Mean	SD	t	p	ES
	Unit 1: Shielded Metal Arc Welding						
9.	Perform safety inspections of equipment & accessories	Welders	3.35	.60	.90	.37	
		Faculty	3.26	.56			
10.	Make minor external repairs to equipment & accessories	Welders	3.65	.64	4.28	.00	.93
		Faculty	3.16	.53			
11.	Set up for shielded metal arc welding operations on plain carbon steel	Welders	3.13	.54	.21	.84	
		Faculty	3.11	.38			
12.	Operate shielded metal arc welding equipment	Welders	3.15	.51	-.38	.70	
		Faculty	3.18	.44			
13.	Make fillet welds, all positions, on plain carbon steel	Welders	3.17	.38	-.40	.69	
		Faculty	3.21	.56			
14.	Make groove welds, all positions, on plain carbon steel	Welders	3.22	.42	-.94	.35	
		Faculty	3.31	.60			
	Unit 2: Gas Metal Arc Welding						
15.	Perform 2G-3G limited thickness qualification tests on plain carbon steel plate	Welders	3.34	.53	-.51	.61	
		Faculty	3.40	.62			
16.	Perform safety inspections of equipment & accessories	Welders	3.37	.68	1.37	.17	
		Faculty	3.21	.52			
17.	Make minor external repairs to equipment & accessories	Welders	3.65	.60	3.39	.00	.60
		Faculty	3.25	.68			
18.	Set up for gas metal arc welding operations on plain carbon steel	Welders	3.24	.43	.17	.86	
		Faculty	3.22	.57			

(table continues)

Item No.	Learning Objectives	Group	Mean	SD	t	p	ES
19.	Operate gas metal arc welding equipment	Welders Faculty	3.40 3.33	.68 .67	.37	.71	
20.	Make fillet welds, all positions, on plain carbon steel	Welders Faculty	3.30 3.19	.55 .59	1.07	.28	
21.	Make groove welds, all positions on plain carbon steel	Welders Faculty	3.35 3.26	.57 .63	.85	.40	
22.	Make 1F-2F fillet welds on plain carbon steel	Welders Faculty	3.48 3.09	.69 .68	3.13	.00	.57
	Unit 3: Flux Cored Arc Welding						
23.	Make 1G groove welds on plain carbon steel	Welders Faculty	3.41 3.14	.65 .68	2.30	.02	.40
24.	Perform safety inspections of equipment & accessories	Welders Faculty	3.37 3.23	.61 .57	1.34	.18	
25.	Make minor external repairs to equipment & accessories	Welders Faculty	3.54 3.20	.59 .63	3.14	.00	.54
26.	Set up for flux cored arc welding operations on plain carbon steel	Welders Faculty	3.35 3.20	.64 .49	1.40	.17	
27.	Operate flux cored arc welding equipment	Welders Faculty	3.52 3.26	.72 .67	2.12	.04	.39
28.	Make fillet welds, all positions, on plain carbon steel	Welders Faculty	3.48 3.19	.72 .73	2.23	.03	.40
29.	Make groove welds, all positions, on plain carbon steel	Welders Faculty	3.52 3.21	.69 .71	2.48	.01	.44
	Unit 4: Gas Tungsten Arc Welding						
30.	Perform safety inspections of equipment & accessories	Welders Faculty	3.46 3.24	.72 .59	1.86	.06	
31.	Make minor external repairs to equipment & accessories	Welders Faculty	3.65 3.23	.67 .73	3.28	.00	.57

(*table continues*)

Item No.	Learning Objectives	Group	Mean	SD	t	p	ES
32.	Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, & stainless steel	Welders	3.46	.66	1.40	.16	
		Faculty	3.30	.62			
33.	Operate gas tungsten arc welding equipment	Welders	3.44	.69	1.21	.22	
		Faculty	3.31	.58			
34.	Make fillet welds, all positions, on plain carbon steel	Welders	3.41	.62	1.58	.12	
		Faculty	3.24	.61			
35.	Make groove welds, all positions, on plain carbon steel	Welders	3.44	.76	1.63	.11	
		Faculty	3.25	.63			
36.	Make 1F-2F welds on aluminum	Welders	3.63	.71	2.58	.01	.48
		Faculty	3.32	.65			
37.	Make 1G welds on aluminum	Welders	3.78	.73	4.17	.00	.76
		Faculty	3.27	.67			
38.	Make 1F-3F welds on stainless steel	Welders	3.76	.77	3.86	.00	.75
		Faculty	3.29	.63			
39.	Make 1G-2G welds on stainless steel	Welders	3.78	.76	3.87	.00	.70
		Faculty	3.28	.71			

Analysis of <u>Course D. Oxyfuel Gas Cutting Principles and Practices</u> (Table 5) indicates nine of the 14 Learning Objectives have probabilities less than .05. Six are significantly different at Cohen's (1977) "medium" level of approximately .50 and three would be considered "large." None of the faculty means were greater than 3.49 and only two of the means for welders were greater than 3.49. These two (Items 47 and 49) were, in the opinion of the welders, in need of having the course content "Increased Slightly." The remaining 12 items were selected by welders to "Leave As Is." Faculty members selected all 14 Learning Objectives to be rated "Leave As Is." According to Tables 8 and 9 (Rank Order), welders ranked only Learning Objective number 47 (Remove weld metal from plain carbon steel using weld washing techniques) in the top 10 and faculty members included none.

Table 6 (Course E. Arc Cutting Principles and Practices) has all *p* values except one less than .05. Only Item 59 (Perform safety inspections of equipment and accessories) had a *p* value of .23 indicating agreement between welders and faculty members at the .05 level of significance. Item 55 (Make minor external repairs to equipment and accessories) had the largest ES value (1.08) observed in the entire study.

Table 5

Statistics for Learning Objectives

Course D. Oxyfuel Gas Cutting Principles and Practices

Item No.	Learning Objectives	Group	Mean	SD	t	p	ES
	Unit 1: Manual Oxyfuel Gas Cutting						
40.	Perform safety inspections of equipment & accessories	Welders	3.37	.68	.79	.43	
		Faculty	3.29	.56			
41.	Make minor external repairs to equipment & accessories	Welders	3.35	.60	1.64	.10	
		Faculty	3.18	.58			
42.	Set up for manual oxyfuel gas cutting operations on plain carbon steel	Welders	3.17	.53	.59	.56	
		Faculty	3.12	.39			
43.	Operate manual oxyfuel gas cutting equipment	Welders	3.24	.64	.83	.41	
		Faculty	3.15	.44			
44.	Perform straight cutting operations on plain carbon steel	Welders	3.35	.60	1.71	.09	
		Faculty	3.18	.50			
45.	Perform shape cutting operations on plain carbon steel	Welders	3.48	.69	2.51	.01	.59
		Faculty	3.19	.49			
46.	Perform beveled cutting operations on plain carbon steel	Welders	3.48	.69	2.38	.02	.47
		Faculty	3.22	.55			
47.	Remove weld metal on plain carbon steel using weld washing techniques	Welders	3.72	.78	4.34	.00	.81
		Faculty	3.15	.70			
	Unit 2: Machine Oxyfuel Gas Cutting						
48.	Perform safety inspections of equipment & accessories	Welders	3.39	.58	2.56	.01	.48
		Faculty	3.14	.52			
49.	Make minor external repairs to equipment & accessories	Welders	3.57	.69	4.11	.00	.77
		Faculty	3.08	.64			

(table continues)

Item No.	Learning Objectives	Group	Mean	SD	t	p	ES
50.	Set up for machine oxyfuel gas cutting operations on plain carbon steel	Welders Faculty	3.30 3.04	.51 .50	2.93	.00	.52
51.	Operate machine oxyfuel gas cutting equipment	Welders Faculty	3.46 3.08	.69 .57	3.42	.00	.67
52.	Perform straight cutting operations on plain carbon steel	Welders Faculty	3.33 3.03	.60 .53	2.99	.00	.57
53.	Perform beveled cutting operations on plain carbon steel	Welders Faculty	3.37 3.07	.57 .63	2.70	.01	.48

Three of the 10 Learning Objectives correspond to Cohen's (1977) suggested "medium ES" of .50 and the remaining six are closer to the "large ES" of .80. All of the Learning Objectives, except Item 59 (Perform safety inspections of equipment and accessories), were rated "Leave As Is" by faculty members and "Increase Slightly" by welders. Item 59 was rated "Leave As Is" by both faculty and welders and also has the strongest *t*-test agreement. Course E. has clearly been judged by the welders as needing a slight increase in content based on the mean values.

Table 6

Statistics for Learning Objectives

Course E. Arc Cutting Principles and Practices

Item No.	Learning Objectives	Group	Mean	SD	t	p	ES
	Unit 1: Air Carbon Arc Cutting						
54.	Perform safety inspections of equipment & accessories	Welders Faculty	3.52 3.09	.75 .61	3.62	.00	.70
55.	Make minor external repairs to equipment & accessories	Welders Faculty	3.65 3.00	.67 .60	5.86	.00	1.08
56.	Set up for manual air carbon arc gouging & cutting operations on plain carbon steel	Welders Faculty	3.50 3.18	.69 .65	2.75	.01	.49
57.	Operate manual air carbon arc cutting equipment	Welders Faculty	3.74 3.19	.71 .68	4.46	.00	.81
58.	Perform metal removal operations on plain carbon steel	Welders Faculty	3.76 3.25	.71 .70	4.08	.00	.73
	Unit 2: Plasma Arc Cutting						
59.	Perform safety inspections of equipment & accessories	Welders Faculty	3.39 3.26	.68 .50	1.21	.23	
60.	Make minor external repairs to equipment & accessories	Welders Faculty	3.65 3.24	.64 .67	3.43	.00	.61
61.	Set up for manual plasma arc cutting operations on plain carbon steel, aluminum, & stainless steel	Welders Faculty	3.54 3.21	.75 .58	2.69	.01	.57
62.	Operate manual plasma arc cutting equipment	Welders Faculty	3.70 3.26	.76 .63	3.66	.00	.70
63.	Perform shape cutting operations on plain carbon steel, aluminum, & stainless steel	Welders Faculty	3.78 3.29	.74 .64	4.02	.00	.77

Table 7 (Course F. Welding Inspection and Testing Principles) contains only two Learning Objectives (Items 64 and 65). Both items were rated "Leave As Is" by the faculty and "Increase Slightly" by the welders. This indicates that the faculty were satisfied with Course F. as it was currently being offered and that the welders felt the course content should be increased. Although welders want the course content increased, Table 10, Comparative Rank Order, indicates that faculty members rank both Learning Objectives higher than do the welders. Both probability values were at or above the .05 level and their respective Effect Sizes were calculated. Each would be rated as a "medium ES" according to Cohen (1977).

Table 7

Statistics for Learning Objectives

Course F. Welding Inspection and Testing Principles

Item No.	Learning Objectives	Group	Mean	SD	*t*	*p*	ES
64.	Examine cut surfaces & edges of prepared base metal parts	Welders	3.59	.69	2.36	.02	.43
		Faculty	3.30	.67			
65.	Examine tack, intermediate layers, & completed welds	Welders	3.67	.79	1.98	.05	.36
		Faculty	3.41	.73			

Rank Order of Learning Objectives

Tables 8,9, and 10 on the following pages have the mean response values listed in rank order for each of the 65 Learning Objectives, from largest to smallest. Table 8 gives the rankings for welders; Table 9 ranks the faculty members; and Table 10 compares the rankings between the welders and faculty. The tables of rankings present another way of looking at the degree of emphasis placed on individual learning objectives. As with previous tables, mean values between 2.50 and 3.49 indicate that the course content of the Learning Objective is satisfactory ("Leave As Is") and values between 3.50 and 4.49 indicate "Increase Slightly." Twenty-seven of the Learning Objectives received means from the welders indicating a desire to "Increase Slightly" whereas only one item was selected by faculty members for an increase. Therefore, 38 Learning Objectives were ranked by welders and 64 by faculty with ratings to "Leave As Is." Table 10 compares the rankings between the two populations and indicates only one Learning Objective on which there is agreement. Item number 8, (Fabricate parts from a drawing or sketch) was ranked number 1 by both welders and faculty. The only other Learning Objectives which appeared to have close agreement according to the rankings were items 64, 27, 30, and 41. Item 55 has a ranking of 14 by the welders and 64 by faculty members.

This appears to be the largest discrepancy among the rankings. None of the rankings has a mean value which recommends a decrease in content of any Learning Objectives.

Summary

A listing of 118 welders and 251 faculty members was provided by the American Welding Society (AWS) as the two populations for this study. Questionnaires were sent to each of the total of 369. The response rates were calculated after adjusting the totals to account for those which were returned as undeliverable or not applicable. The final adjusted response rates were 44.4% for welders and 45.8% for faculty.

A table was presented for the analysis of the six courses offered in the training program. Each of the six courses was also presented in tabular form by analyzing the Learning Objectives in each course. The analysis consisted of using a two-tailed t-test for independent variables at the .05 level of significance to determine if a significant difference existed between the mean values of the two populations. These tables include the mean, standard deviation, t values, probability, p, and effect size ES.

Rank-Order Tables were constructed for both welders and faculty based on their mean response values. A comparative Rank-Order Table was also presented to indicate the

Table 8

Rank Order of Learning Objectives-Welders

Rank	Mean	Item	Learning Objective
1.	3.80	8.	Fabricate parts from a drawing or sketch.
2.	3.78	39.	Make 1G-2G welds on stainless steel.
3.	3.78	37.	Make 1G welds on aluminum.
4.	3.78	63.	Perform shape cutting operations on plain carbon steel, aluminum, and stainless steel.
5.	3.76	58.	Perform metal removal operations on plain carbon steel.
6.	3.76	38.	Make 1F-3F welds on stainless steel.
7.	3.74	57.	Operate manual air carbon arc cutting equipment.
8.	3.74	7.	Interpret welding symbol information.
9.	3.72	47.	Remove weld metal from plain carbon steel using weld washing techniques (manual burning).
10.	3.70	62.	Operate manual plasma arc cutting equipment.
11.	3.67	65.	Examine tack, intermediate layers, and completed welds.
12.	3.67	6.	Interpret basic elements of a drawing or sketch.
13.	3.65	60.	Make minor repairs to equipment and accessories (plasma).
14.	3.65	55.	Make minor repairs to equipment and accessories (air arc).
15.	3.65	31.	Make minor repairs to equipment and accessories (GTAW).
16.	3.65	17.	Make minor repairs to equipment and accessories (GMAW).
17.	3.65	10.	Make minor repairs to equipment and accessories (SMAW).
18.	3.63	36.	Make 1F-2F welds on aluminum.

(table continues)

Rank	Mean	Item	Learning Objective
19.	3.59	64.	Examine cut surfaces and edges of prepared base metal parts.
20.	3.57	49.	Make minor external repairs to equipment and accessories (machine burning).
21.	3.54	61.	Set up for manual plasma arc cutting operations on plain carbon steel, aluminum, and stainless steel.
22.	3.54	25.	Make minor external repairs to equipment and accessories (FCAW).
23.	3.52	54.	Perform safety inspections of equipment and accessories.
24.	3.52	29.	Make groove welds, all positions, on plain carbon steel (FCAW).
25.	3.52	27.	Operate flux cored arc welding equipment.
26.	3.52	5.	Follow written details to complete work assignments.
27.	3.50	56.	Set up for manual air carbon arc gouging and cutting operations on plain carbon steel.
28.	3.48	46.	Perform beveled cutting operations on plain carbon steel (manual burning).
29.	3.48	45.	Perform shape cutting operations on plain carbon steel (manual burning).
30.	3.48	28.	Make fillet welds, all positions, on plain carbon steel (FCAW).
31.	3.48	22.	Make 1F-2F fillet welds on plain carbon steel (GMAW).
32.	3.46	51.	Operate machine oxyfuel gas cutting equipment
33.	3.46	32.	Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel.
34.	3.46	30.	Perform safety inspections of equipment and accessories (GTAW).
35.	3.44	35.	Make groove welds, all positions, on plain carbon steel (GTAW).

(table continues)

Rank	Mean	Item	Learning Objective
36.	3.44	33.	Operate gas tungsten arc welding equipment.
37.	3.41	34.	Make fillet welds, all positions, on plain carbon steel (GTAW).
38.	3.41	23.	Make 1G groove welds on plain carbon steel (GMAW).
39.	3.41	4.	Follow verbal instructions to complete work assignments.
40.	3.40	19.	Operate gas metal arc welding equipment.
41.	3.39	59.	Perform safety inspections of equipment and accessories (plasma).
42.	3.39	48.	Perform safety inspections of equipment and accessories (machine burning).
43.	3.37	53.	Perform beveled cutting operation on plain carbon steel (machine burning).
44.	3.37	40.	Perform safety inspections on equipment and accessories (manual burning).
45.	3.37	24.	Perform safety inspections of equipment and accessories (FCAW).
46.	3.37	16.	Perform safety inspections of equipment and accessories (GMAW).
47.	3.35	44.	Perform straight cutting operations on plain carbon steel (manual burning).
48.	3.35	41.	Make minor repairs to equipment and accessories (manual burning).
49.	3.35	26.	Set up for flux cored arc welding operations on plain carbon steel.
50.	3.35	21.	Make groove welds, all positions, on plain carbon steel (GMAW).
51.	3.35	9.	Perform safety inspections of equipment and accessories (SMAW).

(*table continues*)

Rank	Mean	Item	Learning Objective
52.	3.34	15.	Perform 2G-3G limited the thickness qualification tests on plain carbon steel plate (SMAW).
53.	3.33	52.	Perform straight cutting operations on plain carbon steel (machine burning).
54.	3.33	3.	Perform housekeeping duties.
55.	3.33	1.	Follow safe practices.
56.	3.30	50.	Set up for machine oxyfuel gas cutting operations on plain carbon steel.
57.	3.30	20.	Make fillet welds, all positions, on plain carbon steel (GMAW).
58.	3.27	2.	Prepare time or job cards reports or records.
59.	3.24	43.	Operate manual oxyfuel gas cutting equipment.
60.	3.24	18.	Set up for gas metal arc welding operations on plain carbon steel.
61.	3.22	14.	Make groove welds, all positions, on plain carbon steel (SMAW).
62.	3.17	42.	Set up for manual oxyfuel gas cutting operations on plain carbon steel.
63.	3.17	13.	Make fillet welds, all positions, on plain carbon steel (SMAW).
64.	3.15	12.	Operate shielded metal arc welding equipment.
65.	3.13	11.	Set up for shielded metal arc welding operations on plain carbon steel.

Table 9

Rank Order of Learning Objectives-Faculty

Rank	Mean	Item	Learning Objective
1.	3.61	8.	Fabricate parts from a drawing or sketch.
2.	3.44	7.	Interpret welding symbol information.
3.	3.44	4.	Follow verbal instructions to complete work assignments.
4.	3.42	5.	Follow written details to complete work assignments.
5.	3.41	6.	Interpret basic elements of a drawing or sketch.
6.	3.41	65.	Examine tack, intermediate layers, and completed welds.
7.	3.40	15.	Perform 2G-3G limited the thickness qualification tests on plain carbon steel plate.
8.	3.36	1.	Follow safe practices.
9.	3.33	19.	Operate gas metal arc welding equipment.
10.	3.32	36.	Make 1F-2F welds on aluminum.
11.	3.31	33.	Operate gas tungsten arc welding equipment.
12.	3.31	14.	Make groove welds, all positions, on plain carbon steel (SMAW).
13.	3.30	64.	Examine cut surfaces and edges of prepared base metal parts.
14.	3.30	32.	Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel.
15.	3.29	38.	Make 1F-3F welds on stainless steel.
16.	3.29	63.	Perform shape cutting operations on plain carbon on plain carbon steel, aluminum, and stainless steel.
17.	3.29	40.	Perform safety inspections on equipment and accessories (manual burning).
18.	3.29	3.	Perform housekeeping duties.

(table continues)

Rank	Mean	Item	Learning Objective
19.	3.28	39.	Make 1G-2G welds on stainless steel.
20.	3.27	37.	Make 1G welds on aluminum.
21.	3.26	27.	Operate flux cored arc welding equipment.
22.	3.26	62.	Operate manual plasma arc cutting equipment.
23.	3.26	59.	Perform safety inspections of equipment and accessories (plasma).
24.	3.26	21.	Make groove welds, all positions, on plain carbon steel (GMAW).
25.	3.26	17.	Make minor repairs to equipment and accessories (GMAW).
26.	3.26	9.	Perform safety inspections of equipment and accessories (SMAW).
27.	3.25	58.	Perform metal removal operations on plain carbon steel.
28.	3.25	35.	Make groove welds, all positions, on plain carbon steel (GTAW).
29.	3.24	60.	Make minor repairs to equipment and accessories (plasma).
30.	3.24	30.	Perform safety inspections of equipment and accessories (GTAW).
31.	3.24	34.	Make fillet welds, all positions, on plain carbon steel (GTAW).
32.	3.23	31.	Make minor repairs to equipment and accessories (GTAW).
33.	3.23	24.	Perform safety inspections of equipment and accessories (FCAW).
34.	3.22	46.	Perform beveled cutting operations on plain carbon steel (manual burning).
35.	3.22	18.	Set up for gas metal arc welding operations on plain carbon steel.

(table continues)

Rank	Mean	Item	Learning Objective
36.	3.21	16.	Perform safety inspections of equipment and accessories (GMAW).
37.	3.21	29.	Make groove welds, all positions, on plain carbon steel (FCAW).
38.	3.21	61.	Set up for manual plasma arc cutting operations on plain carbon steel aluminum, and stainless steel.
39.	3.21	13.	Make fillet welds, all positions, on plain carbon steel (SMAW).
40.	3.20	26.	Set up for flux cored arc welding operations on plain carbon steel.
41.	3.20	25.	Make minor external repairs to equipment and accessories (FCAW).
42.	3.19	45.	Perform shape cutting operations on plain carbon steel (manual burning).
43.	3.19	20.	Make fillet welds, all positions, on plain carbon steel (GMAW).
44.	3.19	28.	Make fillet welds, all positions, on plain carbon steel (FCAW).
45.	3.19	57.	Operate manual air carbon arc cutting equipment.
46.	3.18	44.	Perform straight cutting operations on plain carbon steel (manual burning).
47.	3.18	12.	Operate shielded metal arc welding equipment.
48.	3.18	56.	Set up for manual air carbon arc gouging and cutting operations on plain carbon steel.
49.	3.18	41.	Make minor repairs to equipment and accessories (manual burning).
50.	3.16	10.	Make minor repairs to equipment and accessories (SMAW).
51.	3.15	47.	Remove weld metal from plain carbon steel using weld washing techniques (manual burning).
52.	3.15	43.	Operate manual oxyfuel gas cutting equipment.

(*table continues*)

Rank	Mean	Item	Learning Objective
53.	3.14	48.	Perform safety inspections of equipment and accessories (machine burning).
54.	3.14	23.	Make 1G groove welds on plain carbon steel (GMAW).
55.	3.12	42.	Set up for manual oxyfuel gas cutting operations on plain carbon steel.
56.	3.11	11.	Set up for shielded metal arc welding operations on plain carbon steel.
57.	3.09	22.	Make 1F-2F fillet welds on plain carbon steel (GMAW).
58.	3.09	54.	Perform safety inspections of equipment and accessories.
59.	3.08	51.	Operate machine oxyfuel gas cutting equipment.
60.	3.08	49.	Make minor external repairs to equipment and accessories (machine burning).
61.	3.07	53.	Perform beveled cutting operation on plain carbon steel (machine burning).
62.	3.04	50.	Set up for machine oxyfuel gas cutting operations on plain carbon steel.
63.	3.03	52.	Perform straight cutting operations on plain carbon steel (machine burning).
64.	3.00	55.	Make minor repairs to equipment and accessories (air arc).
65.	2.83	2.	Prepare time or job cards reports or records.

Table 10

Comparative Rank Order: Welders vs. Faculty

Rank Welder	Rank Faculty	Item	Learning Objective
1.	1.	8.	Fabricate parts from a drawing or sketch.
2.	19.	39.	Make 1G-2G welds on stainless steel.
3.	20.	37.	Make 1G welds on aluminum.
4.	16.	63.	Perform shape cutting operations on plain carbon steel, aluminum, and stainless steel.
5.	27.	58.	Perform metal removal operations on plain carbon steel.
6.	15.	38.	Make 1F-3F welds on stainless steel.
7.	45.	57.	Operate manual air carbon arc cutting equipment.
8.	2.	7.	Interpret welding symbol information.
9.	51.	47.	Remove weld metal from plain carbon steel using weld washing techniques (manual burning).
10.	22.	62.	Operate manual plasma arc cutting equipment.
11.	6.	65.	Examine tack, intermediate layers, and completed welds.
12.	5.	6.	Interpret basic elements of a drawing or sketch.
13.	29.	60.	Make minor repairs to equipment and accessories (plasma).
14.	64.	55.	Make minor repairs to equipment and accessories (air arc).
15.	32.	31.	Make minor repairs to equipment and accessories (GTAW).
16.	25.	17.	Make minor repairs to equipment and accessories (GMAW).
17.	50.	10.	Make minor external repairs to equipment and accessories (SMAW).

(table continues)

Rank Welder	Rank Faculty	Item	Learning Objective
18.	10.	36.	Make 1F-2F welds on aluminum.
19.	13.	64.	Examine cut surfaces and edges of prepared base metal parts.
20.	60.	49.	Make minor external repairs to equipment and accessories (machine burning).
21.	38.	61.	Set up for manual plasma arc cutting operations on plain carbon steel.
22.	41.	25.	Make minor external repairs to equipment and accessories (FCAW).
23.	58.	54.	Perform safety inspections of equipment and accessories.
24.	37.	29.	Make groove welds, all positions, on plain carbon steel (FCAW).
25.	21.	27.	Operate flux cored arc welding equipment.
26.	4.	5.	Follow written details to complete work assignments.
27.	48.	56.	Set up for manual air carbon arc gouging and cutting operations on plain carbon steel.
28.	34.	46.	Perform beveled cutting operations on plain carbon steel (manual burning).
29.	42.	45.	Perform shape cutting operations on plain carbon steel (manual burning).
30.	44.	28.	Make fillet welds, all positions, on plain carbon steel (FCAW).
31.	57.	22.	Make 1F-2F fillet welds on plain carbon steel (GMAW).
32.	59.	51.	Operate machine oxyfuel gas cutting equipment.
33.	14.	32.	Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel.

(*table continues*)

Rank Welder	Rank Faculty	Item	Learning Objective
34.	30.	30.	Perform safety inspections of equipment and accessories (GTAW).
35.	28.	35.	Make groove welds, all positions, on plain carbon steel (GTAW).
36.	11.	33.	Operate gas tungsten arc welding equipment.
37.	31.	34.	Make fillet welds, all positions, on plain carbon steel (GTAW).
38.	54.	23.	Make 1G groove welds on plain carbon steel (GMAW).
39.	3.	4.	Follow verbal instructions to complete work assignments.
40.	9.	19.	Operate gas metal arc welding equipment.
41.	23.	59.	Perform safety inspections of equipment and accessories (plasma).
42.	53.	48.	Perform safety inspections of equipment and accessories (machine burning).
43.	61.	53.	Perform beveled cutting operation on plain carbon steel (machine burning).
44.	17.	40.	Perform safety inspections on equipment and accessories (manual burning).
45.	33.	24.	Perform safety inspections of equipment and accessories (FCAW).
46.	36.	16.	Perform safety inspections of equipment and accessories (GMAW).
47.	46.	44.	Perform straight cutting operations on plain carbon steel (manual burning).
48.	49.	41.	Make minor repairs to equipment and accessories (manual burning).
49.	40.	26.	Set up for flux cored arc welding operations on plain carbon steel.

(table continues)

Rank Welder	Rank Faculty	Item	Learning Objective
50.	24.	21.	Make groove welds, all positions, on plain carbon steel (GMAW).
51.	26.	9.	Perform safety inspections of equipment and accessories (SMAW).
52.	7.	15.	Perform 2G-3G limited the thickness qualification tests on plain carbon steel plate.
53.	63.	52.	Perform straight cutting operations on plain carbon steel (machine burning).
54.	18.	3.	Perform housekeeping duties.
55.	8.	1.	Follow safe practices.
56.	62.	50.	Set up for machine oxyfuel gas cutting operations on plain carbon steel.
57.	43.	20.	Make fillet welds, all positions, on plain carbon steel (GMAW).
58.	65.	2.	Prepare time or job cards reports or records.
59.	52.	43.	Operate manual oxyfuel gas cutting equipment.
60.	35.	18.	Set up for gas metal arc welding operations on plain carbon steel.
61.	12.	14.	Make groove welds, all positions, on plain carbon steel (SMAW).
62.	55.	42.	Set up for manual oxyfuel gas cutting operations on plain carbon steel.
63.	39.	13.	Make fillet welds, all positions, on plain carbon steel (SMAW).
64.	47.	12.	Operate shielded metal arc welding equipment.
65.	56.	11.	Set up for shielded metal arc welding operations on plain carbon steel.

relationship between the two populations with respect to their opinions. The Rank-Order Tables were presented with those Learning Objectives having the largest mean values at the top of the list.

Tables were also constructed to display the percentage of respondents under each Likert Scale item. A table was presented for each course with its respective Learning Objectives. This was further divided to enable comparison between the opinions of welders and faculty. These tables (11 through 16) are included in Appendix H.

Table 9 indicates that faculty members have chosen to "Increase Slightly" only Learning Objective number 8, Fabricate parts from a drawing or sketch. In this case, the mean value is 3.61; only 0.12 above the critical value of 3.49. All of the remaining 64 Learning Objectives were given a preference of "Leave As Is" by the faculty members. Table 1, Statistics for the Six ELWTP Courses, reveals that none of the means for faculty members exceeds 3.49. All six courses were rated by faculty to "Leave As Is," although Course B. Drawing and Welding Symbol Interpretation received a mean value of 3.49 only 0.01 below the critical value. Table 8 (Rank Order) indicates that the welders have selected 27 of the 65 Learning Objectives to be "Increased Slightly." All of the remaining Learning Objectives have means between 3.48 and 3.13; thus they are rated "Leave As

Is." Of the six ELWTP courses, the welders selected three to have the course content "Increased Slightly":

B. Drawing and Welding Symbol Interpretation.

E. Arc Cutting Principles and Practices.

F. Welding Inspection and Testing Principles.

The remaining three courses received a course content rating of "Leave As Is" by the welders.

Tables 11 through 16 are included in Appendix H. They display the percentages of responses for each Likert Scale response for both welders and faculty. Visual examination of these tables indicates that the overwhelming number of responses are under the number three Likert Scale, "Leave As Is." The second most predominant selection is number four, "Increase Slightly." These six tables show at a glance which Learning Objectives received 50% or more of the responses. That is, where 50% of the welders or 50% of the faculty members would prefer to increase the instructional content of a Learning Objective. The vast majority selected Response 3, "Leave As Is" or Response 4, "Increase Slightly." There were only a few instances where Response 4 exceeded Response 3 in percentage of replies. There were no cases where either welders or faculty members expressed a desire to decrease the instructional content of any of the Learning Objectives of the ELWTP. For welders, only Learning Objectives 17 and 37 had 50% of the responses favoring a slight increase in the amount of training. None of the faculty members' responses equaled 50% in favor of increasing the content of any of the Learning Objectives. In general, both welders and faculty are in favor of leaving the instructional content of the Learning Objectives as it currently is. Welders, more than faculty members, would desire to "Increase Slightly" the instructional content of all the Learning Objectives. Tables 11 through 16 display, convincingly, that neither welders nor faculty members favor a decrease in the content of any of the Learning Objectives.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Study

Chapter 5 includes the following four headings: Summary, Conclusions, Recommendations, and Recommendations for Further Study. The purpose, problem, and research questions are briefly reviewed and the study is summarized. The conclusions drawn from the research are reported and discussed. Finally, recommendations for further study, based on this investigation, are offered.

The problem of this study was to determine which courses offered by the American Welding Society (AWS) Entry Level Welder Training Program (ELWTP) should have the instructional content increased or decreased. This was accomplished through a questionnaire mailed to welders who had successfully completed the training program and faculty members who had taught it. The survey instrument was developed from the AWS specifications and guide upon which the ELWTP is based. A five-point Likert Scale was used to rate the six Basic Courses and their respective 65 Learning Objectives. Population sizes and response rates for welders and faculty were 118 (44.4%) and 251 (45.8%), respectively.

The purpose of the study was to evaluate the ELWTP and to provide this information to the AWS, industry, and educators. The AWS could use the results in their program evaluation cycle for possible curriculum modifications. The study could serve as a basis for continued, related, research. It also could provide insight into the differences of opinion between welders and faculty.

The literature review produced no previous research from which a directional hypothesis could be developed. Therefore, three research questions were established as follows:

1. Which courses and learning objectives of the AWS Entry Level Welder Training Program should have the content increased or decreased based on the opinions of faculty members?

2. Which courses and learning objectives of the AWS Entry Level Welder Training Program should have the content increased or decreased based on the opinions of graduates of the program?

3. What are the similarities and differences between the opinions of faculty members and graduates?

The questions are answered by examining the appropriate tables. The Likert Scale response means are used to evaluate the Courses and Learning Objectives. Values from 2.50 to 3.49 indicate that respondents prefer to "Leave As Is" the course content of the corresponding Course or Learning Objective. Values above 3.49 indicate a preference to "Increase Slightly" the course content.

Research Question number 1 resulted in faculty members selecting all of the six ELWTP Courses to "Leave As Is." Course B. Drawing and Welding Symbol Interpretation received a mean value of 3.49, only 0.01 below the critical value. They selected only Learning Objective number 8, Fabricate Parts from a Drawing or Sketch, to be "Increased Slightly." All of the remaining 64 Learning Objectives were given a preference of "Leave As Is" by the faculty members.

Research Question number 2 was addressed to welders. Welders selected three of the six ELWTP courses to have course content "Increased Slightly":

B. Drawing and Welding Symbol Interpretation.

E. Arc Cutting Principles and Practices.

F. Welding Inspection and Testing Principles.

The remaining three courses received a course content rating of "Leave As Is" by the welders. Welders selected 27 of the 65 Learning Objectives to be "Increased Slightly." All of the remaining Learning Objectives have means between 3.48 and 3.13: thus, they are rated "Leave As Is."

Research Question number 3 seeks similarities and differences in the opinions of faculty members and welders. Course B. Drawing and Welding Symbol Interpretation has the highest mean response value for each population and, therefore, the greatest amount of agreement.

The statistical tests indicate five Courses and a considerable number of Learning Objectives which are statistically significant at the .05 level implying disagreement between the welders and faculty. However, the mean values indicate that both groups generally agree with regard to the amount of training content. Welders, more than faculty, tend to favor an increase in content. Neither group favored a decrease in content for any of the Courses or Learning Objectives. Only Learning Objective number 8, Fabricate Parts from a Drawing or Sketch, has both faculty and welders choosing to "Increase Slightly" the course content. The greatest difference among the two groups is in the number of Learning Objectives selected to have the content "Increased Slightly." Faculty members selected only one, whereas welders selected 27 Learning Objectives.

Further information supporting the analysis of the Research Questions can be obtained from the appropriate Tables. Table 1, Statistics for the Six ELWTP Courses, displays the mean, SD, t, p, and ES values for each course. Tables 2 through 7 list these statistics for each of the 65 Learning Objectives. All of these tables (1 through 7) compare the welders to faculty members. Tables 8, 9, 10 rank the Learning Objectives according to the mean response values. Tables 11 through 16 display the percentage of responses for each Likert Scale response.

Conclusions

The study solicited the opinions of welders and faculty members who participated in the AWS Entry Level Welder Training Program (ELWTP). The research resulted in a number of conclusions based on the findings. The conclusions of the study are as follows:

Courses A through F

1. Of the six ELWTP Courses, only Course B. Drawing and Welding Symbol Interpretation (Table 1) appears to have a preference by both welders and faculty to have the course content "Increased Slightly."

2. Welders are of the opinion that two Courses (other than Course B) should have the content "Increased Slightly":

    Course E. Arc Cutting Principles & Practices
    Course F. Welding Inspection & Testing Principles

3. Faculty members are satisfied with all six courses as they are currently offered, with a tendency toward "Increasing Slightly" the course content.

4. None of the courses was selected by either welders or faculty to have the course content "Decreased" or "Increased Considerably."

Learning Objectives 1 through 65

1. Both, welders and faculty, selected Learning Objective 8 Fabricate Parts From a Drawing or Sketch (Table 3) to have the course content "Increased Slightly."

2. Welders selected 27 Learning Objectives to have the course content "Increased Slightly." This is illustrated in Table 8, Rank Order of Learning Objectives - Welders.

3. All of the welders and faculty selected the remaining Learning Objectives to "Leave As Is."

4. None of the welders or faculty selected any of the Learning Objectives to be decreased in content.

Respondent Comments

Appendix G contains comments added by respondents at the end of the questionnaire. The extra effort put forth to add these notes indicates a high level of interest by the writers. Some comments contained only a sentence or brief message while others were considerably more extensive. Both positive and negative statements were received although none were extremely critical. Both welders and faculty members added comments to 37% of the returned usable questionnaires.

General Conclusions

Based on the statistical analyses using t-tests for two independent populations at the .05 level of significance, the study revealed differences between the opinions of welders and faculty members. Tables of Rank Order (Tables 8, 9, and 10) and Percentage of Responses (Tables 11 through 16) also support this conclusion. Further support was obtained by using Cohen's Tables (1977) to develop the relationship between power, effect size, significance criterion (.05), and sample size, (n). The calculated power value of 0.79 is extremely close to his recommended value of 0.80. The extremes of the Likert Scale were to "Decrease Considerably" or "Increase Considerably." Neither group selected either of these extremes to any great extent. All of the foregoing leads to the conclusion that there is reasonably good agreement between the welders and faculty members based on a practical evaluation of the means.

Recommendations

General recommendations and recommendations for further study are offered based on the findings and conclusions of this study.

1. Course B. Drawing and Welding Symbol Interpretation, should receive serious consideration for having the course content increased.

2. Learning Objective 8, Fabricate Parts From a Drawing or Sketch, should receive serious consideration for having the course content increased.

3. All of the remaining Courses and Learning Objectives should remain as they are.

4. None of the 6 Courses or 65 Learning Objectives of the ELWTP should have the course content decreased.

Recommendations for Further Study

1. A repeat study, similar to this research, should be conducted in a few years to verify the data collected here.

2. A study should be made to evaluate the AWS Level 2 Advanced Welder Program at such time as it becomes firmly established in the educational system.

3. A study should be made to evaluate the AWS Level 3 Expert Welder Program at such time as it becomes firmly established in the educational system.

4. A survey of industry representatives and employers should be conducted similar to this study. This could be accomplished by mailing the surveys to the welders with instructions for forwarding them to their employers.

5. Conduct similar studies of identified geographical areas throughout the United States. More intensely isolated surveys could be used to identify special local needs.

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APPENDIX A

DISSERTATION BUDGET

DISSERTATION BUDGET

(Estimated)

The figures below represent the expenses estimated at the beginning of the study. They were based largely on reviews of other dissertations and interviews with faculty and students.

	Description	Amount
1.	Review of literature	$100.00
2.	Printing, copying, supplies	$500.00
3.	Postage	$600.00
4.	Report, binding, copyright	$200.00
	TOTAL	$1400.00

Actual Expenses

A record of expenses involved in preparing and assembling the dissertation was maintained throughout its progress. Some expenses such as driving costs, telephone calls, incidentals, etc. were not included. Others were estimated in the interest of practicality. No costs were included for any of the time required to type, assemble, and revise the study. The hours of work required were obviously substantial.

Actual Expenses

Description	Amount
UNI Letterhead Return Envelopes with postage	$192.36
Questionnaire Sheets, 11 x 17 Questionnaire Envelopes, 9 x 12	$26.00
Postage out @ $.55 each	$201.85
$1.00 bills for welders	$117.00
Copy questionnaires 367@ $.08	$29.36
Typing, labels, mail merge	$86.00
Rubber stamp	$30.00
Follow Up Postcards to welders, 92 @ $.20	$18.40
Copies, 190 @ $.04	$7.60
Fax letters to faculty 147 @ $.22	$32.34
Postage 38 @ $.32	$12.16
Postage 30 @ $.20	$6.00
Copies 167 @ $.05 + 60 @ $.04	$10.75
Statistical Analysis	$330.00
Printing, Copying, Binding (Estimated)	$200.00
Total	$1299.82

APPENDIX B

SCHEDULE OF ACTIVITIES

SCHEDULE OF ACTIVITIES

Approximate

Activity	Date	
Review of literature, topic selection, and preparation of proposal.	1996-1997	
Prepare questionnaire.	September	1997
Validate questionnaires.	October	1997
Approval of dissertation proposal.	November	1997
Human Subjects Review	"	1997
Mail questionnaires.	"	1997
Send follow-up letters.	December	1997
Prepare Chapters 2 & 3	"	1997
Analyze data and complete dissertation for submittal.	February	1998
Revise original chapters.	"	1998
Oral defense.	March	1998
Make final revisions	March	1998
Print, bind, copyright, etc.	April	1998
Graduation ceremony.	May	1998

APPENDIX C

LIST OF EXPERTS FOR QUESTIONNAIRE VALIDATION

LIST OF EXPERTS FOR QUESTIONNAIRE VALIDATION

Dr. Daryle W. Morgan
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Professor of Engineering Technology
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Coordinator of International Welding Contests
Senior Certified Welding Inspector
Instructor of Certified Welding Inspector Course
Consultant on all matters regarding welding and brazing
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Hampton, VA 23661
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APPENDIX D

HUMAN SUBJECTS REVIEW APPROVAL

The University of Northern Iowa

November 12, 1997

John Rice
Box 400
Dysart, IA 52224

Dear Mr. Rice:

Your project, "An Evaluation of the American Welding Society (AWS) Entry Level Welder Training Program (ELWTP)," which you submitted for human subjects review on 11/7/97 has been determined to be exempt from further review under the guidelines stated in the UNI Human Subjects Handbook. You may commence participation of human research subjects in your project.

Your project need not be submitted for continuing review unless you alter it in a way that increases the risk to the participants. If you make any such changes in your project, you should notify the Graduate College Office.

If you decide to seek federal funds for this project, it would be wise not to claim exemption from human subjects review on your application. Should the agency to which you submit the application decide that your project is not exempt from review, you might not be able to submit the project for review by the UNI Institutional Review Board within the federal agency's time limit (30 days after application). As a precaution against applicants' being caught in such a time bind, the Board will review any projects for which federal funds are sought. If you do seek federal funds for this project, please submit the project for human subjects review no later than the time you submit your funding application.

If you have any further questions about the Human Subjects Review System, please contact me. Best wishes for your project.

Sincerely,

Norris M. Durham, Ph.D.
Chair, Institutional Review Board

cc: Dr. David A. Walker, Associate Dean

Graduate College 1 Seerley Cedar Falls, Iowa 50614-0702 (319) 273-2748 FAX: (319) 273-2243

APPENDIX E

SURVEY INSTRUMENT

(Questionnaire)

AN EVALUATION OF THE AWS ENTRY LEVEL

WELDER TRAINING PROGRAM

Instructions

Please evaluate the AWS Training Program for Entry Level Welders (EG 2.0 -95) by indicating your assessment of the following learning objectives. The questionnaire goal is to determine your opinion of whether the amount of instruction of each learning objective should be increased, decreased, or remain as it currently is. This information will eventually be made available to the AWS for their use in curriculum analysis and, hopefully, improvements.

Feel free to call collect with any questions (John Rice, day 319-476-2990 or evening 319-476-5015, or fax 319-476-7927).

Rate each LEARNING OBJECTIVE by circling the appropriate number which emphasizes whether the instructional content should be increased or decreased.

Courses & Learning Objectives (From EG 2.0 - 95, pp. 16-86)	Decrease Considerably	Decrease Slightly	Leave as is	Increase Slightly	Increase Considerably
1. Course A. Occupational Orientation					
1. 1. Follow safe practices	1	2	3	4	5
2. 2. Prepare time or job cards [reports or records].	1	2	3	4	5
3. 3. Perform housekeeping duties.	1	2	3	4	5
4. 4. Follow verbal instructions.	1	2	3	4	5
5. 5. Follow written details to complete work assignments.	1	2	3	4	5

Courses & Learning Objectives	Decrease Considerably	Decrease Slightly	Leave as is	Increase Slightly	Increase Considerably
2. Course B. Drawing and Welding Symbol Interpretation					
6. 1. Interpret basic elements of a drawing or sketch.	1	2	3	4	5
7. 2. Interpret welding symbol information.	1	2	3	4	5
8. 3. Fabricate parts from a drawing or sketch.	1	2	3	4	5
3. Course C. Arc Welding Principles and Practices					
Unit 1: Shielded Metal Arc Welding					
9. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5
10. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
11. 3. Set up for shielded metal arc welding operations on plain carbon steel.	1	2	3	4	5
12. 4. Operate shielded metal arc welding equipment.	1	2	3	4	5
13. 5. Make fillet welds, all positions, on plain carbon steel.	1	2	3	4	5
14. 6. Make groove welds, all positions, on plain carbon steel.	1	2	3	4	5
15. 7. Perform 2G-3G limited thickness qualification tests on plain carbon steel plate.	1	2	3	4	5
Unit 2: Gas Metal Arc Welding					
16. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5

Courses & Learning Objectives	Decrease Considerably	Decrease Slightly	Leave as is	Increase Slightly	Increase Considerably
17. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
18. 3. Set up for gas metal arc welding operations on plain carbon steel.	1	2	3	4	5
19. 4. Operate gas metal arc welding equipment.	1	2	3	4	5
Short Circuit Transfer					
20. 5. Make fillet welds, all positions, on plain carbon steel.	1	2	3	4	5
21. 6. Make groove welds, all positions, on plain carbon steel.	1	2	3	4	5
Spray Transfer					
22. 7. Make 1F-2F fillet welds on plain carbon steel.	1	2	3	4	5
23. 8. Make 1G groove welds on plain carbon steel.	1	2	3	4	5
Unit 3: Flux Cored Arc Welding.					
24. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5
25. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
26. 3. Set up for flux cored arc welding operations on plain carbon steel.	1	2	3	4	5
27. 4. Operate flux cored arc welding equipment.	1	2	3	4	5
28. 5. Make fillet welds, all positions, on plain carbon steel.	1	2	3	4	5
29. 6. Make groove welds, all positions, on plain carbon steel.	1	2	3	4	5
Unit 4: Gas Tungsten Arc Welding					
30. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5

Courses & Learning Objectives	Decrease Considerably	Decrease Slightly	Leave as is	Increase Slightly	Increase Considerably
31. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
32. 3. up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel.	1	2	3	4	5
33. 4. Operate gas tungsten arc welding equipment.	1	2	3	4	5
34. 5 Make fillet welds, all positions, on plain carbon steel.	1	2	3	4	5
35. 6. Make groove welds, all positions, on plain carbon steel.	1	2	3	4	5
36. 7. Make 1F-2F welds on aluminum.	1	2	3	4	5
37. 8. Make 1G welds on aluminum.	1	2	3	4	5
38. 9. Make 1F-3F welds on stainless steel.	1	2	3	4	5
39. 10. Make 1G-2G welds on stainless steel.	1	2	3	4	5
4. Course D. Oxyfuel Gas Cutting Principles and Practices					
Unit 1: Manual Oxyfuel Gas Cutting.					
40. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5
41. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
42. 3. Set up for manual oxyfuel gas cutting operations on plain carbon steel.	1	2	3	4	5
43. 4. Operate manual oxyfuel gas cutting equipment.	1	2	3	4	5
44. 5. Perform straight cutting operations plain carbon steel.	1	2	3	4	5

Courses & Learning Objectives	Decrease Considerably	Decrease Slightly	Leave as is	Increase Slightly	Increase Considerably
45. 6. Perform shape cutting operations on plain carbon steel.	1	2	3	4	5
46. 7. Perform beveled cutting operations on plain carbon steel.	1	2	3	4	5
47. 8. Remove weld metal on plain carbon steel using weld washing techniques.	1	2	3	4	5
Unit 2: Machine Oxyfuel Gas Cutting (track burner)					
48. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5
49. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
50. 3. Set up for machine oxyfuel gas cutting operations on plain carbon steel.	1	2	3	4	5
51. 4. Operate machine oxyfuel gas cutting equipment.	1	2	3	4	5
52. 5. Perform straight cutting operations on plain carbon steel.	1	2	3	4	5
53. 6. Perform beveled cutting operations on plain carbon steel.	1	2	3	4	5
5. Course E. Arc Cutting Principles and Practices					
Unit 1: Air Carbon Arc Cutting					
54. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5
55. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
56. 3. Set up for manual air carbon arc gouging and cutting operations on plain carbon steel.	1	2	3	4	5

Courses & Learning Objectives	Decrease Considerably	Decrease Slightly	Leave as is	Increase Slightly	Increase Considerably
57. 4. Operate manual air carbon arc cutting equipment.	1	2	3	4	5
58. 5. Perform metal removal operations on plain carbon steel.	1	2	3	4	5
Unit 2: Plasma Arc Cutting					
59. 1. Perform safety inspections of equipment and accessories.	1	2	3	4	5
60. 2. Make minor external repairs to equipment and accessories.	1	2	3	4	5
61. 3. Set up for manual plasma arc cutting operations on plain carbon steel, aluminum, and stainless steel.	1	2	3	4	5
62. 4. Operate manual plasma arc cutting equipment.	1	2	3	4	5
63. 5. Perform shape cutting operations on plain carbon steel, aluminum, and stainless steel.	1	2	3	4	5
6. Course F. Welding Inspection and Testing Principles					
Unit 1: Visual Examination Principles and Practices					
64. 1. Examine cut surfaces and edges of prepared base metal parts.	1	2	3	4	5
65. 2. Examine tack, intermediate layers, and completed welds.	1	2	3	4	5

Please use the space below or a separate sheet of paper for any additional comments.

APPENDIX F

COVER LETTERS AND FOLLOW-UP

The University of Northern Iowa

John Rice
Box 400
Dysart, IA 52224
Home Phone: 319-476-5015
Office Phone: 319-476-2990
Fax: 319-476-7927

November 20, 1997

Davis Applied Technology
550 East 300 South
Kaysville, UT 84037

Attention: Jeff Strahan

Dear Mr. Strahan:

The accompanying 15-minute questionnaire is being sent to you as part of a Doctoral Dissertation regarding the evaluation of the AWS Training Program for Entry Level Welders. The results of this study will produce information leading to improvements in education and training, plus increased marketability, for all welders. Continual upgrading will provide the level of training required to remain current with advancing technology. Educators, welders, and society will all share in the benefits.

As a faculty member, you have hopefully received feedback from industry and former students concerning the content of the training program. Could an increase or decrease in the amount of instruction in any of the areas better prepare welders for employment? If you have not taught courses in the program, please pass the survey on to a faculty member who has, or return it to me with a note of explanation.

Would you kindly complete the form to the best of your ability and return it in the self-addressed envelope as soon as your schedule permits within the next two weeks? I really need your help with this project.

All responses will be treated confidentially with only statistical results being reported. Thank you for your time, effort, and participation.

Kind regards,

John Rice
Doctoral Candidate

Department of Industrial Technology
Industrial Technology Center 25 Cedar Falls, Iowa 50614-0178 (319) 273-2561 FAX: (319) 273-5818

The University of Northern Iowa

John Rice
Box 400
Dysart, IA 52224
Home Phone: 319-476-5015
Office Phone: 319-476-2990
Fax: 319-476-7927

November 20, 1997

Gerald Andrews
4842 W. 61st Ave.
Arvada, CO 80003

Dear Mr. Andrews:

The accompanying 15-minute questionnaire is being sent to you as part of a Doctoral Dissertation regarding the evaluation of the AWS Training Program for Entry Level Welders. The results of this study will produce information leading to improvements in education and training, plus increased marketability, for all welders. Continual upgrading will provide the level of training required to remain current with advancing technology. Educators, welders, and society will all share in the benefits.

As a graduate of the Training Program, currently out in the "real" world, you are in a position to express a meaningful opinion about whether the content of the course learning objectives should be increased or decreased. Could an increase or decrease in the amount of instruction in any of the areas better prepare welders for employment?

Would you kindly complete the form to the best of your ability and return it in the self-addressed envelope as soon as your schedule permits within the next two weeks?

All responses will be treated confidentially with only statistical results being reported. Thank you for your time, effort, and participation.

Kind regards,

John Rice
Doctoral Candidate

P.S. Please buy yourself a cup of coffee, soft drink, or candy bar with the enclosed dollar. I really need your help with this project.

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The University of Northern Iowa

John Rice
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December 12, 1997

A few days ago a questionnaire was sent to you asking your opinion of the AWS Entry Level Welder Training program. The results of this survey will be provided to the AWS for curriculum improvements to benefit welders, educators, and society.

Please complete and return the questionnaire in the next day or two if you have not already done so. I need your response to complete the project data analysis. Call me collect if there is a problem.

Please accept my personal thanks if this reminder and your response have crossed in the mail.

Kind regards,

John Rice
Doctoral Candidate

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Industrial Technology Center 25 Cedar Falls, Iowa 50614-0178 (319) 273-2561 FAX: (319) 273-5818

APPENDIX G

RESPONDENT COMMENTS

Respondent Comments

The questionnaire included a space for both welders and faculty to add their comments. Some returns were personally signed, some contained business cards, and others included full-page letters. The explicitness of these comments ranged from major disagreement with the ELWTP to profuse thankfulness for the opportunities provided. The comments included here have been reproduced nearly word-for-word except for minor editing and condensing to protect the respondent's identification as agreed in the original cover letters. The comments are separated according to welders and faculty but are in no particular order.

Welder Comments

1. This AWS program is such a gift to our society, also makes such an advancement in the welder's life. I can never thank the AWS programmers and sponsors as well as instructors enough! Thank you.

2. I thought everything was fine as it was. However, I wasn't the typical welding student. Since then I've gone back into Electrical Engineering, working with software. Welding school is pretty much history by now and I got everything out of it I wanted. Hindsight being 20/20, I wouldn't change anything. It was all very positive.

3. I was surprised when I took the entry level AWS test, that it seemed to ask questions of courses I had taken previously at KY Tech, ie., Industrial Safety - "what class fire extinguisher will extinguish a gasoline fire?" I studied pretty hard for the test in my welding text and was taken back when I read this question and many similar to that, that weren't just welding questions. Anyway just an observation - probably my assumption was wrong of what the test would be like. Good Luck

4. I feel that more time needs to be focused on the spray transfer in GMAW & Air Carbon Arc Cutting -- no offense -- (it) is like a joke to the AWS training course. AWS needs to make prints that involve a great deal of Air Carbon Arc Cutting. Get the students to do a lot more hands on work.

5. The main problem I think is not enough advanced, high tech equipment in the classrooms today. When I was in Voc. school a couple of years ago we had about 12 stick machines, 2 mig machines, 1 tig machine and just about the time I left we got a plasma cutter, which I used once. It was very hard for 20 to 25 people to use the advanced welding practices simply because there weren't enough machines to go around. Don't get me wrong, I'm not saying stick welding is outdated or anything, but since I've been in fab shops mig is used 2 to 1. I'm certified in all three processes and I think tig is the hardest. Tig is a fine art that takes lots of practice, now how can 20 to 25 people get the practice they need to go to a job interview and proudly say I'm a certified tig welder. I'm just saying I think the practices should be more equally divided in the classrooms today.

6. I am very happy with the course I took. Although I think the time allotted was too short.

7. Course was life changing trade wise! Very beneficial.

8. I went to ATC in Weber county and I was happy, except for their lack in the blue printing program. And the fact that your peers are judging your work and can pass or fail it. Only the teacher has the experience to do that I think.

9. I think the AWS program is a good standard for welders. I also believe that the AWS should get more involved with the businesses that practice welding.

10. What would be the next test to take?

11. Overall, I was quite pleased with the program. Since I've been out in the workforce, I think there are a few things that need a little more attention. I did learn a lot from the program and for that I say thanks!

12. The instructor that I had, did an excellent job;..with the program. The written part (the test) needs to be revised.

13. Thanks for the dollar, sorry my response took so long.

14. Thanks for the coffee.

15. I feel that those of us who wanted to learn did, those who just wanted the certification kicked back and got it. I only learned cause I asked a lot of questions and learned with others. It's kind of sad cause I see guys now who are getting credit for it & didn't really do it.

16. The AWS course for entry level welders is a good course, however, I felt more time could have been spent on perfecting actual welding skills. I observed many people pass the course with weld appearance that wasn't satisfactory in my opinion.

17. I earned my certificate in prison, I am currently still incarcerated and have not yet used skills in society, although I do continue to work in the prison welding shop.

18. 1) More stainless SMAW, GMAW, 2) More tests such as bend, to make student more comfortable with test after training, 3) More attention to GTAW on aluminum such as groove welds.

Faculty Comments

1. John, we are converting to semesters next year & will be incorporating this curriculum more. We haven't followed it enough to evaluate.

2. How can one make minor repairs if machines are not broken? I disagree to even having this in the program. (Refers to making minor repairs to equipment in all six courses.)

3. The objectives give an instructor the benefit of teaching each separate process. I feel that this is well written & comprehensive. I would plan Course F

to be in front of Unit 2 where the bend tests are located, not at the end.

4. The Entry Level should be broken up into 6 parts (as you have done). A number of my advisory committee would like to see the course done in parts as none of them use all the parts.

5. John, I wish you the very best on your project.

6. We do not do Course C, Unit 2, Spray Transfer. We do not do Course D, Unit 2. We do not do Course E, Unit 1.

7. Here in Texas most industrial jobs certify their welders through their own schools for the job the welder is to perform. I know of only one job in the Gatesville area that certify with AWS. And the only reason is because they perform gov't contracts. Most training in industry is going with Wheels of Learning made by the National Center for Construction Education and Research.

8. We have adopted Wheels of Learning. Sorry we couldn't help.

9. This is our second year in the Entry Level Welding Program and overall it is a step above other formats. I would like to make the following suggestions as far as some minor improvements.

   Stress verbal communication more.

   Change the work sampling on arc welding from performing the 2G-3G qualification test to the all position 3G-4G limited thickness test. The trainees already have the skills.

   The written tests are fine, with one exception, some of the questions refer to drawings of, for example, a GMAW torch head. If the student has memorized the exact sequence of the order gas in, power and liner they get the correct answer, but if they know the components but put them in the wrong order, they are wrong. The reality of the individual components being in the same order as depicted in the workbook is unrealistic. The most important thing is to know the components and recognize them in any order.

I would suggest some form of work sampling for the oxyfuel manual cutting. We add a work sampling where the student has to cut, as specified in a drawing, a piece of 3/8" carbon steel. This should be to a certain size with dimensions for hole location, bevel, and slot.

10. Problem: I feel only about 10% or less of students will be able to handle this AWS Entry Level Welder Program. In today's world of child study teams and special education students, most of us vocational instructors are at a disadvantage because of a student's low academic areas. I have attended meetings with Bob Reeve on this AWS program.

11. Decrease the electrical questions.

12. Without a doubt, industry in the Kansas City area is moving in the direction of their employees knowing more theory involving their respective welding processes. In reviewing the AWS certification written test, however, I'm not sure Level I has to go into as much detail on power sources. Feel free to call me if you would like to discuss this further.

13. How do you know what I teach? My students get jobs. Learn on the job, minimum instruction (course E, Unit 1.) What I teach has no bearing on what or how much or what someone else teaches. If I spend a lot of time in one area maybe I need to decrease and vice-versa.

14. Will this be used for the National Skills Standards? Please let me know.

15. I conducted a "class' last spring with 12 students entitled "AWS Welder Certification". Only 5 students completed the course passing the written test and completing all the required assignments. It's a great deal of work for everyone involved; tons of paper work on the instructors part, daily weld inspection for the C.W.I., and a heck-of-a-lot of work on the part of the students. For their efforts they received a beautiful certificate but No I.D. card! -- Not Fair. For $25.00 they could take a simple pre-qualified test in about an hour and get an I.D. card via QC4. I learned a great deal conducting our first ELW class and I am

better preparing my students for spring 98. I just hope AWS is educating industry on just how expensive & demanding this certification is on everyone involved.

16. Welders are replaced by robots now! Program is time consuming with no good future for our students! Our mini program could still be in place for a while, but not for (much) longer.

17. All new methods in welding. Procedures need(to be) up-graded considerably, especially on computerized equipment.

18. As of right now meeting this standard is all I can do. It is sound, and a clean layout. It leaves flexibility, it is my best draw---to be able to offer a national registered credential.

19. I may be wrong but our curriculum is being cut all the time. To be a welder requires practice and more practice. I like the AWS program because it provides for more hands on so please keep it that way.

20. John, I have not yet started using this program, but I have looked over it. In my opinion this training program is OK. However the written test that students must take is far too difficult.

21. 1) The entry level is working great in conjunction with Hobart Training Materials. 2) The program (EG2.0-95) is set at a level of skill & knowledge that is great to date!

22. At this point in time we are not specifically following the AWS curriculum. At some point in the future we might, but right now we are only a test site for AWS certification.

23. Evaluation made by our senior welding instructor, we like the program, but we certainly agree, that it needs some revision. I have noted the areas I feel are weak.

24. I feel the safety portion of the written examination leaves too little margin for pass/fail. I feel that possibly 23 or 25 should be a cutoff point. Safety is great but let's not knock someone out of their certification because of, perhaps a misunderstood

question, 23-25 should be acceptable. 27 is too stringent.

25. A lot of the answers are based on the Lexington area and how my advisory committee has advised me to instruct my class.

26. I disagree with the short circuit transfer performance test done on 3/8" plate for .075" wire. Sorry this is late. Would like to talk to you about AWS program.

27. I haven't as yet completed a full year of teaching the entry level welder curriculum, but in reviewing it I have found it to be adequate in all areas. Local industry in Utah says that the welders coming out of high school have good welding skills but need more training in blueprint reading and layout.

28. At this time we are not using the AWS Training Program for Entry Level Welders. We are working toward that goal in the next two years. Our students are still currently being AWS certified.

29. Excerpts from Welding Educators Meeting

AWS recommendation was 1200 hours of training with approximately 800 hours of classroom/lab hands-on training.

Instructors present feel that only entry level welder book one can be accomplished over a two year period for welding students.

Question raised concerning if all schools are willing to invest the cost of having welding instructors become CWE and CWI in accordance with AWS standards?

Will the schools pay renewal fees and other necessary costs to have AWS status?

Question raised concerning liability issues related to an instructor and/or school certifying program students that will then use this credential to work in industry?

Question concerning the quality of the student entering the welding program. Any pre-screening, as per AWS? If not, then is the program at jeopardy due to limited student abilities and those with lack of interest.

Great need to have more metrics taught in math with AWS standards.

30. Received your request for evaluation of the AWS Entry Level welding program. We are pleased to give you our opinion of the program.

This is an adult education school. We train adults who are in need of retraining, due to loss of their job from downsizing or their place of employment moving out of the area. We also cater to clients who are recovering from drug and alcohol abuse. The welding program is a 720 hour basic welding course. We teach SMA, GTA, GMA welding, basic math, and blueprint reading skills. Our students are able to find work as welders. We have an 89% placement for those who are ready and willing to go to work. The welding course graduates about 25 students a year. We are able to fill the needs of the community, meeting the demand for welders.

Since we started the AWS-ELW program in 1995, we have had one student complete and get certification. I have asked others to give you an evaluation of the course, including our math and blueprint instructor.

My feelings toward the AWS-ELW program is that it's an idea that is long overdue. This country needs to have standards in the welding industry if we want to compete in a world wide market. The problem with our implementing the program is the willingness to extend our existing course from 720 hours to the 1300 hours that the AWS recommends to become certified. Their argument is you are able to place your students in entry level jobs, why extend the course. The local welding community is not willing to pay a welder the scale that an AWS-ELW should be paid. They seem to want an employee who is supposed to be able to do it all for unskilled labor wages. The work ethic of the 90's is such that the current generation does not have the motivation and discipline to develop the skills needed to learn such a demanding craft.

The AWS needs to work very hard to explain to the education and industrial community the advantages of this program. We also must contact our elected officials and convince them to provide funding for those who are willing to spend the time and effort to learn this great wonderful craft.

I hope this letter will help you and want to thank you for allowing us to explain our feelings about a subject that we love. Welding is a gift that is unlike any other. It becomes a part of you and stays with you for all of your life. I tell my students "IF YOU DON'T LOVE IT, GET THE HELL OUT"!

Good luck and please contact us if we can be of help.

31. The previous instructor has retired and I have completed five students in this (program). The only thing with the test was that some of the questions had no answer.

32. We have found some mistakes in both the blueprints & answer key. We also are more restrictive on re-tests.

33. I would like to see a small increase in the making of small weldments or projects. Students learn better by measuring, cutting, and assembling such parts.

34. We are currently using KY TECH curriculum, that is assigned and evaluated by the State of Kentucky. I have received copies of the AWS entry level welder training program, and I feel certain we will be incorporating it in our curriculum in the near future.

35. I have only been using the program for a year and find that serious equipment upgrades are needed to run the program with the efficiency needed. The major need now is to try to get help w/grants or other funding sources to overcome the short fall in modern technology. On average, this shop is 10-15 years behind.

36. Sorry I'm late. In my neck of the world welders must be able to fabricate which means fractions/print reading, layout work.

37. Welding inspection and testing, should include the following: dye penetrant, zyglo, magnaflux testing.

APPENDIX H

PERCENTAGE OF RESPONSES FOR EACH LIKERT SCALE ITEM

Table 11

Percentage of Responses for Each Likert Scale Item

Course A. Occupational Orientation

(W = Welders, F = Faculty)

Likert Scale Items:

1. Decrease Considerably
2. Decrease Slightly
3. Leave As Is
4. Increase Slightly
5. Increase Considerably

Item No.	Learning Objective		Percentages 1	2	3	4	5
1.	Follow safe practices.	W	2	0	65	29	4
		F	0	3	62	31	4
2.	Prepare time or job cards reports or records.	W	2	9	55	27	7
		F	5	19	66	8	2
3.	Perform housekeeping duties.	W	0	4	59	37	0
		F	0	2	73	20	5
4.	Follow verbal instructions.	W	0	4	52	42	2
		F	0	2	61	28	9
5.	Follow written details to complete work assignments.	W	0	2	50	41	7
		F	0	2	59	34	5

Table 12

Percentage of Responses for Each Likert Scale Item

Course B. Drawing and Welding Symbol Interpretation

(W = Welders, F = Faculty)

Likert Scale Items:

1. Decrease Considerably
2. Decrease Slightly
3. Leave As Is
4. Increase Slightly
5. Increase Considerably

Item No.	Learning Objective		Percentages 1	2	3	4	5
6.	Interpret basic elements of a drawing or sketch.	W	0	2	41	44	13
		F	0	3	62	26	9
7.	Interpret welding symbol information.	W	0	0	46	35	19
		F	0	3	58	31	8
8.	Fabricate parts from a drawing or sketch.	W	2	0	35	41	22
		F	0	3	49	32	16

Table 13

Percentage of Responses for Each Likert Scale Item

Course C. Arc Welding Principles and Practices

(W = Welders, F = Faculty)

Likert Scale Items:

1. Decrease Considerably
2. Decrease Slightly
3. Leave As Is
4. Increase Slightly
5. Increase Considerably

Item No.	Learning Objective		Percentages 1	2	3	4	5
	Unit 1: Shielded Metal Arc Welding						
9.	Perform safety inspections of equipment and accessories.	W	0	2	66	28	4
		F	0	4	68	26	2
10.	Make minor external repairs to equipment and accessories.	W	0	0	43	48	9
		F	1	3	76	19	1
11.	Set up for shielded metal arc welding operations on plain carbon steel.	W	2	2	76	0	0
		F	0	1	88	10	1
12.	Operate shielded metal arc welding equipment.	W	2	0	78	20	0
		F	0	1	81	17	1
13.	Make fillet welds, all positions, on plain carbon steel.	W	0	0	83	17	0
		F	0	3	77	16	4
14.	Make groove welds, all positions, on plain carbon steel.	W	0	0	78	22	0
		F	0	1	74	19	6
15.	Perform 2G-3G limited thickness qualification tests on plain carbon steel plate.	W	0	0	68	30	2
		F	0	2	62	31	5

(table continues)

Item No.	Learning Objective		Percentages 1	2	3	4	5
	Unit 2: Gas Metal Arc Welding						
16.	Perform safety inspections of equipment and accessories.	W	0	4	61	28	7
		F	0	2	78	17	3
17.	Make minor external repairs to equipment and accessories.	W	0	0	41	52	7
		F	1	4	70	19	6
18.	Set up for gas metal arc welding operations on plain	W	0	0	76	24	0
		F	0	1	82	11	6
19.	Operate gas metal arc welding equipment.	W	0	0	70	20	10
		F	0	0	78	11	11
20.	Make fillet welds, all positions, on plain carbon steel.	W	0	2	68	28	2
		F	0	5	75	16	4
21.	Make groove welds, all positions, on plain carbon steel.	W	0	2	63	33	2
		F	0	5	70	20	5
22.	Make 1F-2F fillet welds on plain carbon steel.	W	0	2	56	33	9
		F	2	9	69	17	3
23.	Make 1G groove welds on plain carbon steel.	W	0	4	55	37	4
		F	2	7	69	19	3
	Unit 3: Flux Cored Arc Welding						
24.	Perform safety inspections of equipment and accessories.	W	0	0	70	24	6
		F	0	3	75	18	4
25.	Make minor external repairs to equipment and accessories.	W	0	0	50	46	4
		F	1	5	70	21	3
26.	Set up for flux cored arc welding operations on plain carbon steel.	W	0	2	67	24	7
		F	0	2	78	18	2
27.	Operate flux cored arc welding equipment.	W	0	2	54	33	11
		F	0	4	74	14	8

(table continues)

Item No.	Learning Objective		Percentages 1	2	3	4	5
28.	Make fillet welds, all positions, on plain carbon steel.	W	0	2	59	28	11
		F	1	7	72	12	8
29.	Make groove welds, all positions, on plain carbon steel.	W	0	0	59	30	11
		F	1	6	71	15	7
	Unit 4: Gas Tungsten Arc Welding						
30.	Perform safety inspections of equipment and accessories.	W	0	2	61	26	11
		F	0	3	75	17	5
31.	Make minor external repairs to equipment and accessories.	W	0	0	46	43	11
		F	1	6	70	15	8
32.	Set up for gas tungsten arc welding operations on plain carbon steel, aluminum, and stainless steel.	W	0	0	63	28	9
		F	0	2	72	20	6
33.	Operate gas tungsten arc welding equipment.	W	0	0	67	22	11
			0	0	75	19	6
34.	Make fillet welds, all positions, on plain carbon steel.	W	0	0	65	28	7
		F	0	3	76	15	6
35.	Make groove welds, all positions, on plain carbon steel.	W	2	0	58	31	9
		F	0	4	73	17	6
36.	Make 1F-2F welds on aluminum.	W	0	2	44	44	10
		F	0	2	72	18	8
37.	Make 1G welds on aluminum.	W	0	2	33	50	15
		F	1	2	73	17	7
38.	Make 1F-3F welds on stainless steel.	W	0	0	43	37	20
		F	0	4	68	23	5
39.	Make 1G-2G welds on stainless steel.	W	0	0	41	39	20
		F	1	5	65	23	6

Table 14

Percentage of Responses for Each Likert Scale Item

Course D. Oxyfuel Gas Cutting Principles and Practices

(W = Welders, F = Faculty)

Likert Scale Items:

1. Decrease Considerably
2. Decrease Slightly
3. Leave As Is
4. Increase Slightly
5. Increase Considerably

Item No.	Learning Objective		1	2	3	4	5
			Percentages				
	Unit 1: Manual Oxyfuel Gas Cutting						
40.	Perform safety inspections of equipment and accessories.	W	0	2	67	22	9
		F	0	2	70	25	3
41.	Make minor external repairs to equipment and accessories.	W	0	2	66	28	4
		F	1	4	73	20	2
42.	Set up for manual oxyfuel gas cutting operations on plain carbon steel.	W	0	2	83	11	4
		F	0	1	87	11	1
43.	Operate manual oxyfuel gas cutting equipment.	W	2	0	74	20	4
		F	0	1	85	12	2
44.	Perform straight cutting operations on plain carbon steel.	W	0	2	66	28	4
		F	0	1	84	11	4
45.	Perform shape cutting operations on plain carbon steel.	W	0	2	57	33	8
		F	0	1	82	14	3
46.	Perform beveled cutting operations on plain carbon steel.	W	0	2	57	33	8
		F	0	2	78	16	4
47.	Remove weld metal on plain carbon steel using weld washing techniques.	W	0	0	48	33	19
		F	2	7	68	19	4

(table continues)

Item No.	Learning Objective		Percentages 1	2	3	4	5
	Unit 2: Machine Oxyfuel Gas Cutting						
48.	Perform safety inspections of equipment and accessories.	W F	0 1	0 3	65	31	4
49.	Make minor external repairs to equipment and accessories.	W F	0 3	0 5	54 74	35 16	11 2
50.	Set up for machine oxyfuel gas cutting operations on plain carbon steel.	W F	0 2	0 3	72 85	26 9	2 1
51.	Operate machine oxyfuel gas cutting equipment.	W F	0 2	0 3	65 83	24 9	11 3
52.	Perform straight cutting operations on plain carbon steel.	W F	0 2	0 4	74 85	20 7	6 2
53.	Perform beveled cutting operations on plain carbon steel.	W F	0 2	0 5	68 82	28 6	4 5

Table 15

Percentage of Responses for Each Likert Scale Item

Course E. Arc Cutting Principles and Practices (W = Welders,

W = Welders, F = Faculty)

Likert Scale Items:

1. Decrease Considerably
2. Decrease Slightly
3. Leave As Is
4. Increase Slightly
5. Increase Considerably

Item No.	Learning Objective		Percentages 1	2	3	4	5
	Unit 1: Air Carbon Arc Cutting						
54.	Perform safety inspections of equipment and accessories.	W	0	2	57	28	13
		F	3	2	81	11	3
55.	Make minor external repairs to equipment and accessories.	W	0	0	46	43	11
		F	3	6	81	8	2
56.	Set up for manual air carbon arc gouging and cutting operations on plain carbon steel.	W	0	0	61	28	11
		F	2	2	78	13	5
57.	Operate manual air carbon arc cutting equipment.	W	0	0	41	44	15
		F	2	4	72	17	5
58.	Perform metal removal operations on plain carbon steel.	W	0	0	39	46	15
		F	2	3	68	22	5
	Unit: 2 Plasma Arc Cutting						
59.	Perform safety inspections of equipment and accessories.	W	0	4	59	30	7
		F	0	0	78	19	3
60.	Make minor external repairs to equipment and accessories.	W	0	0	43	48	9
		F	1	4	71	18	6

(table continues)

Item No.	Learning Objective		Percentages 1	2	3	4	5
61.	Set up for manual plasma arc cutting operations on plain carbon steel, aluminum, and stainless steel.	W	0	0	61	24	15
		F	0	2	82	10	6
62.	Operate manual plasma arc cutting equipment.	W	0	0	48	35	17
		F	0	2	79	11	8
63.	Perform shape cutting operations on plain carbon steel, aluminum, and stainless steel.	W	0	0	40	42	18
		F	1	1	72	20	6

Table 16

Percentage of Responses for Each Likert Scale Item

Course F. Welding Inspection and Testing Principles

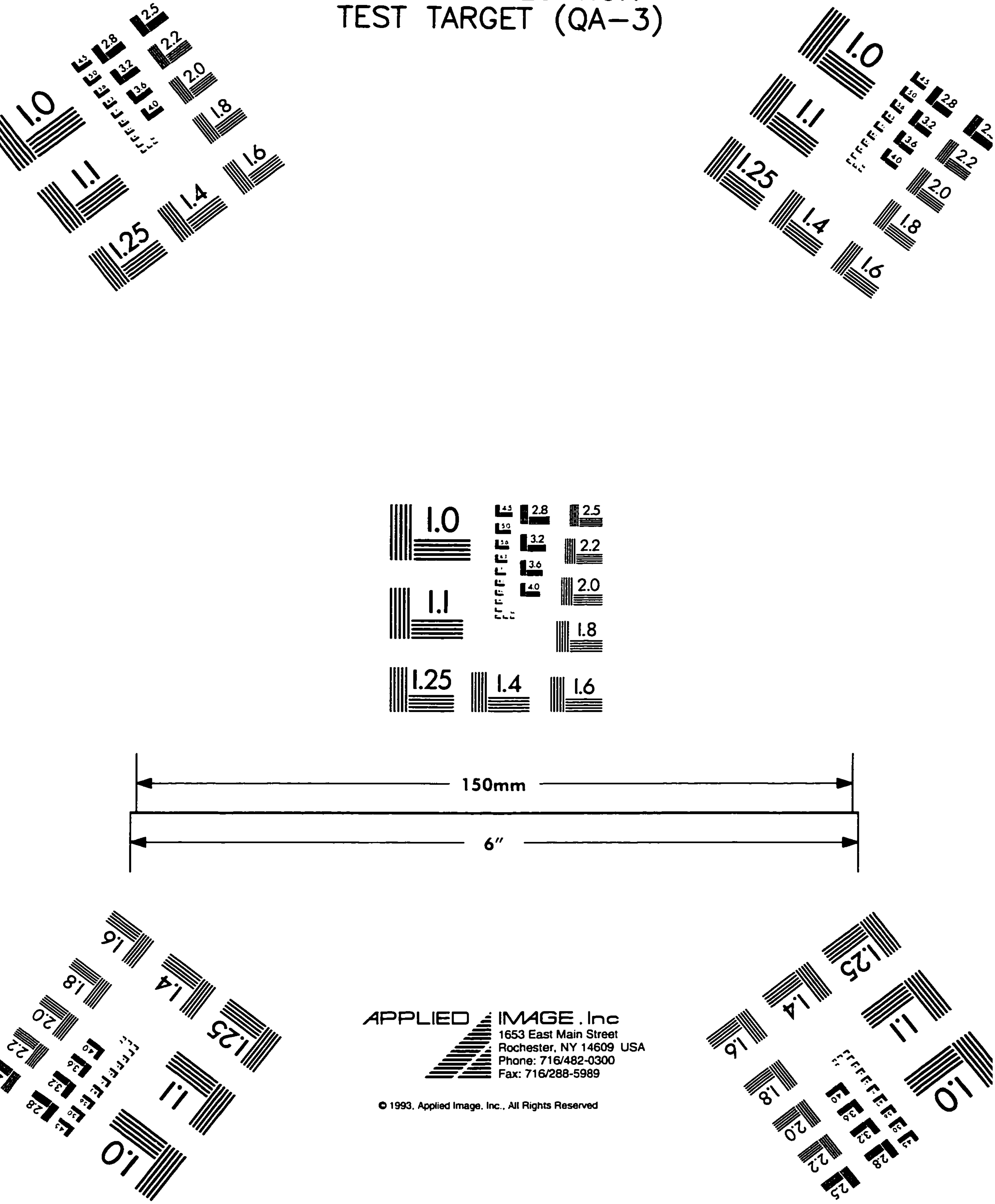
(W = Welders, F = Faculty)

Likert Scale Items:

1. Decrease Considerably
2. Decrease Slightly
3. Leave As Is
4. Increase Slightly
5. Increase Considerably

Item No.	Learning Objective		Percentages 1	2	3	4	5
64.	Examine cut surfaces and edges of prepared base metal parts.	W	0	0	52	37	11
		F	0	4	69	20	7
65.	Examine tack, intermediate layers, and completed welds.	W	0	0	52	28	20
		F	0	3	65	21	11

IMAGE EVALUATION TEST TARGET (QA-3)



150mm

6"

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